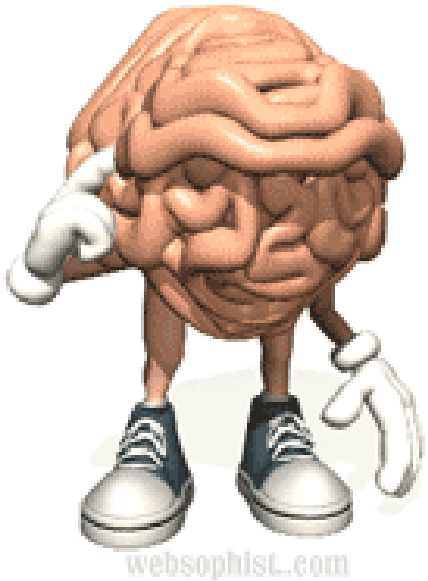
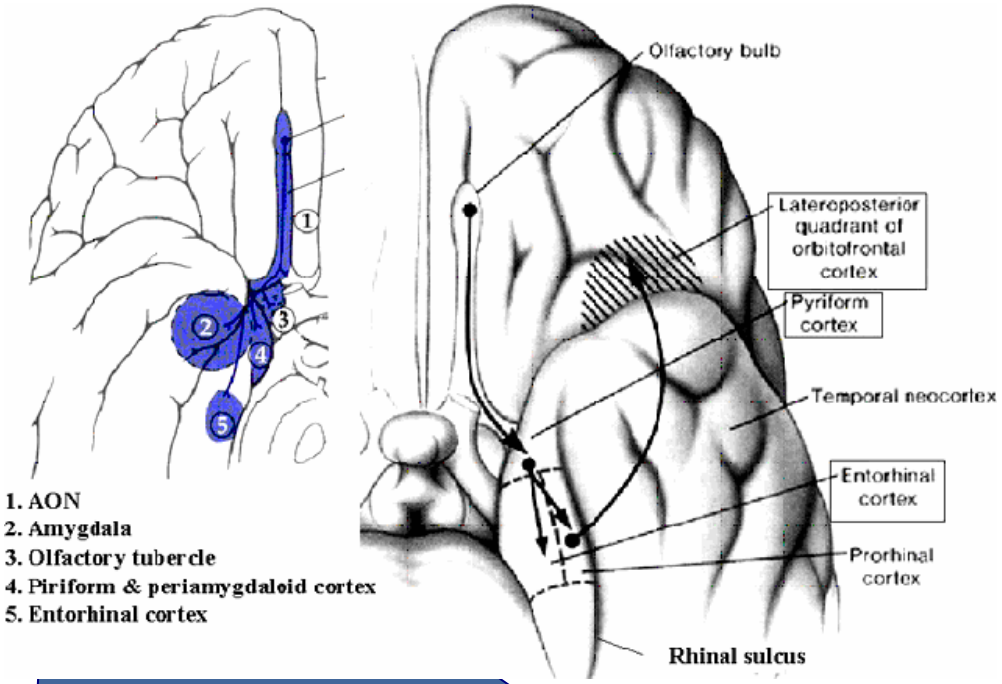


Telencephalon – part 2

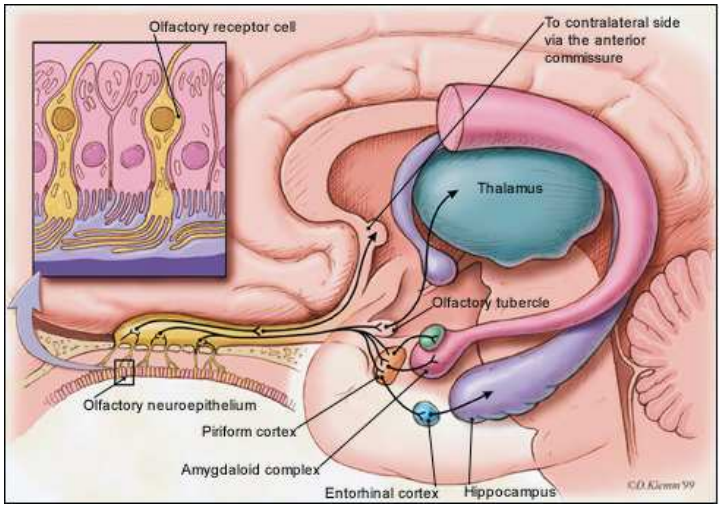
1. Olfactory system, rhinencephalon
2. Limbic system:
   - ✓ hippocampal formation
   - ✓ amygdala
3. Main cortical areas:
   - ✓ sensory areas of the cortex
   - ✓ motor areas of the cortex
4. Functional localization in the cerebrum

Olfactory system, rhinencephalon

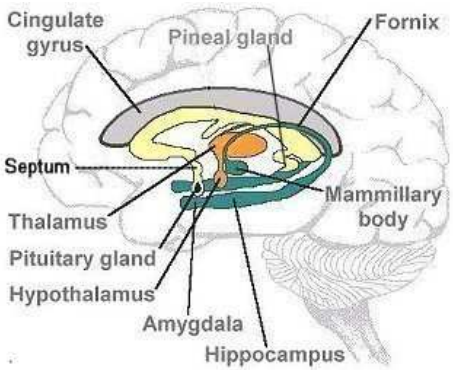
- Gr. *rhinencephalon* = nose-brain
  rhin = nose, *encephalon* = brain
- part of the basal forebrain
- mediates olfaction (the sense of smell), olfactory brain



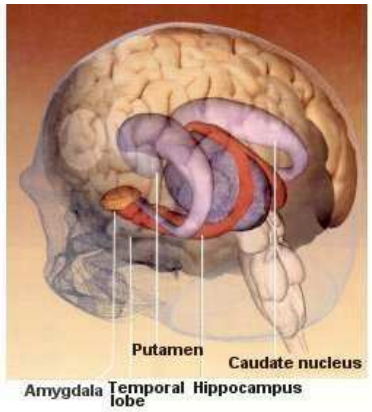
- rhinencephalon includes:
  - ✓ olfactory bulb and tract
  - ✓ olfactory striae and trigone
  - ✓ olfactory tubercle
  - ✓ primary olfactory cortex:
    - ➢ piriform area *(gyrus ambiens)*
    - ➢ periamygdaloid area *(gyrus semilunaris)*
  - ✓ secondary olfactory cortex:
    - ➢ entorhinal area, cranial part of parahippocampal gyrus



Limbic system



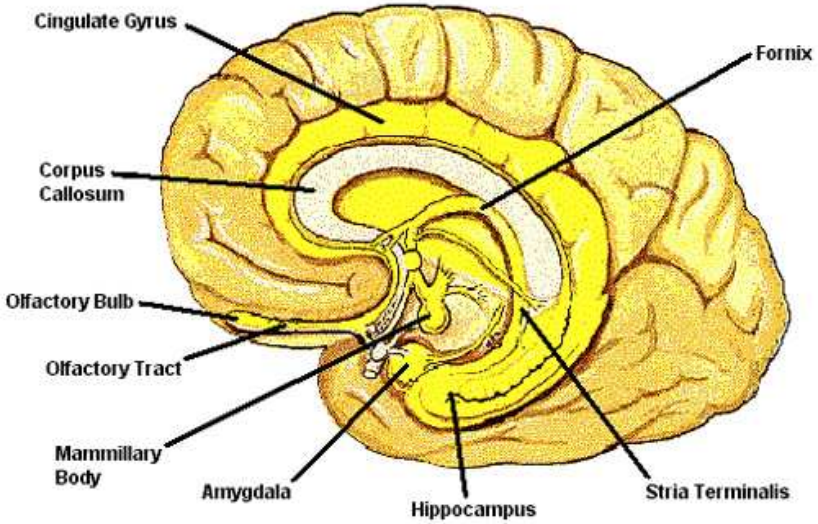
The Limbic System



- Papez circuit, 1937:
  - ✓ a route the limbic system communicates between the hippocampus, thalamus, hypothalamus, and cortex
- Functions – cortical control of:
  - ✓ long-term memory
  - ✓ learning
  - ✓ emotions

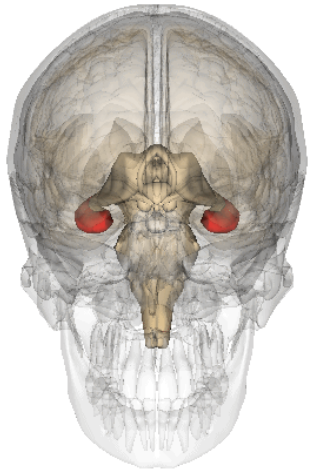

Jamez Papez (1883-1958)

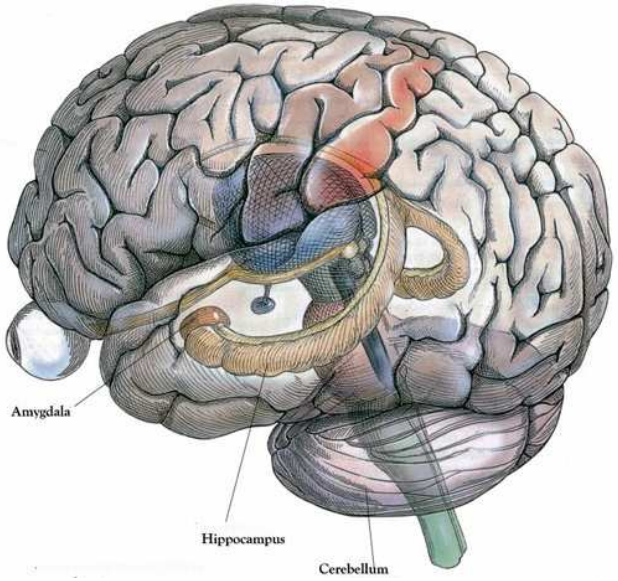
- Limbic system:
  Lat. *limbus* = "border", "belt"
- paleopallium (old mammalian) brain
- cortical structures – limbic lobe
- subcortical nuclei:
  - ✓ hippocampal formation and fornix
  - ✓ amygdaloid nuclear complex
  - ✓ septal nuclei
  - ✓ hypothalamus, epithalamus
  - ✓ various thalamic nuclei
  - ✓ part of the basal ganglia



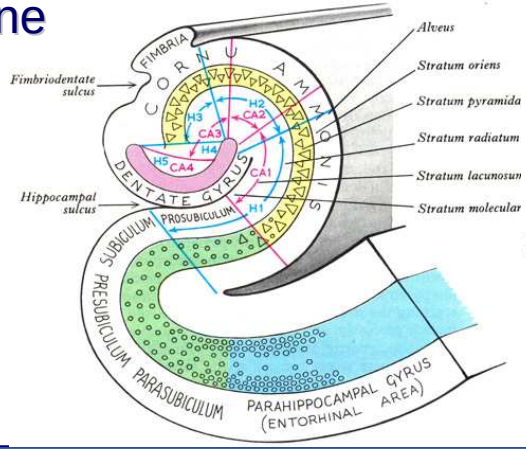
Hippocampal formation

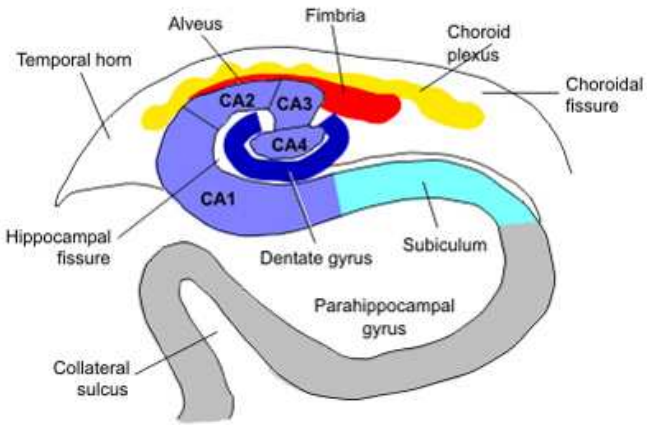
- Hippocampus, seahorse:
  Gr.ιππος, *hippos* = horse,
  καμπος, *kampos* = sea monster
- location – inside
  the medial temporal lobe
- three major regions:
  - ✓ hippocampus proper (Ammon's horn) – CA1-CA4 fields of *Lorente de Nó*
  - ✓ dentate gyrus
    - ➢ three-layered cortices
  - ✓ subiculum – transition zone
- hippocampal functions:
  - ✓ behavioral inhibition (anxiety)
  - ✓ learning and recent memory
  - ✓ spatial coding





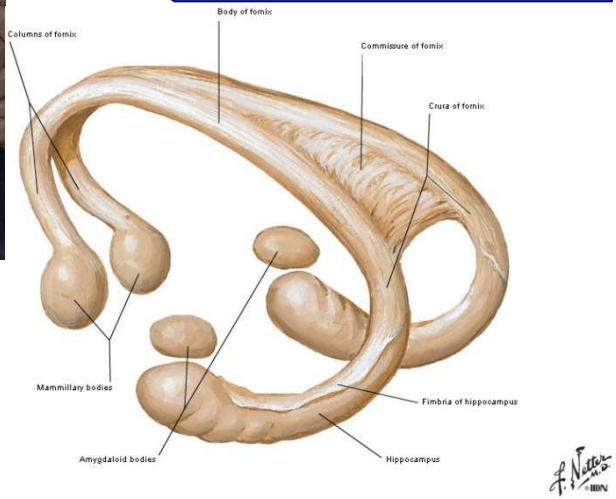
Hippocampal Anatomy



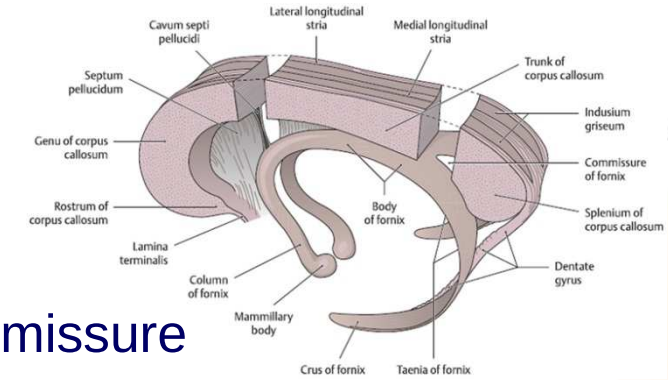


Fornix

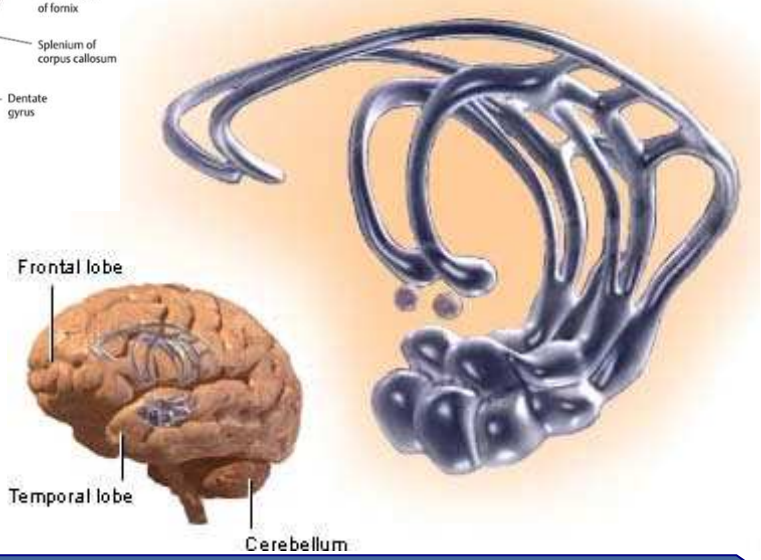
- Fornix, Lat. = “vault”, “arch”
  - ✓ C-shaped bundle of fibres (axons)
  - ✓ the sole efferent system
  - ✓ carries signals from the hippocampus to the mammillary bodies and septal nuclei



- Structure:
  - ✓ crus of the fornix
  - ✓ body of the fornix
  - ✓ (hippocampal) commissure
  - ✓ anterior fibers, "precommissural fornix" ⇨ the septal nuclei and nucleus accumbens
  - ✓ posterior fibres, "postcommissural fornix“ (column of the fornix) ⇨ the mammillary bodies

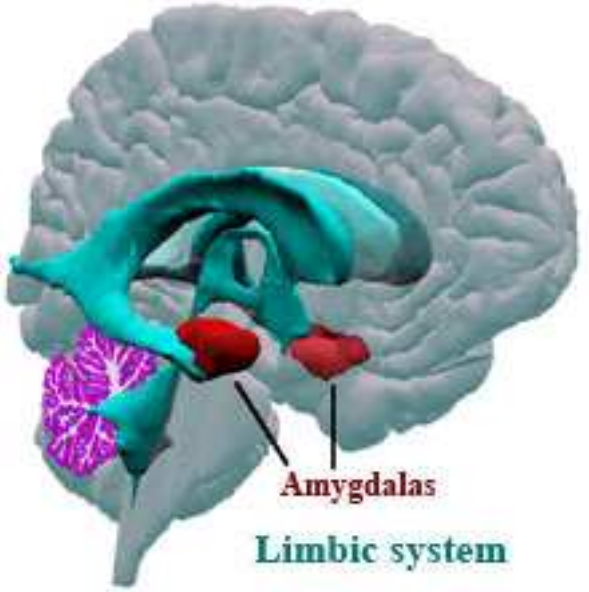


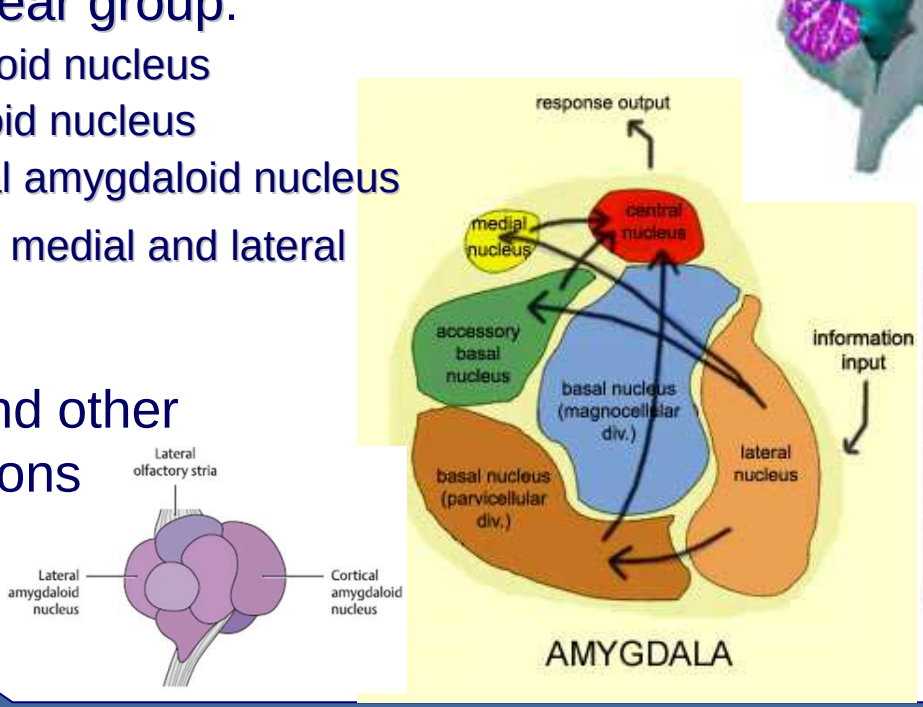
Hippocampus and fornix (limbic system)

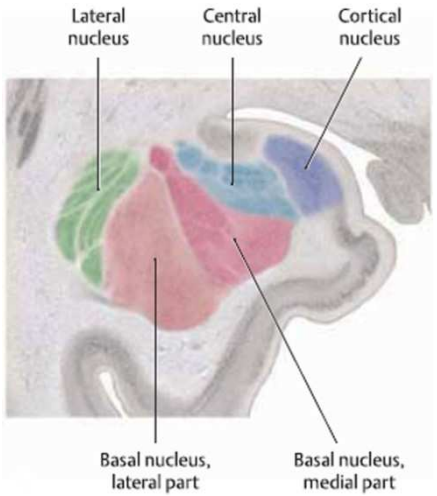


Amygdala (amygdaloid nuclear complex)

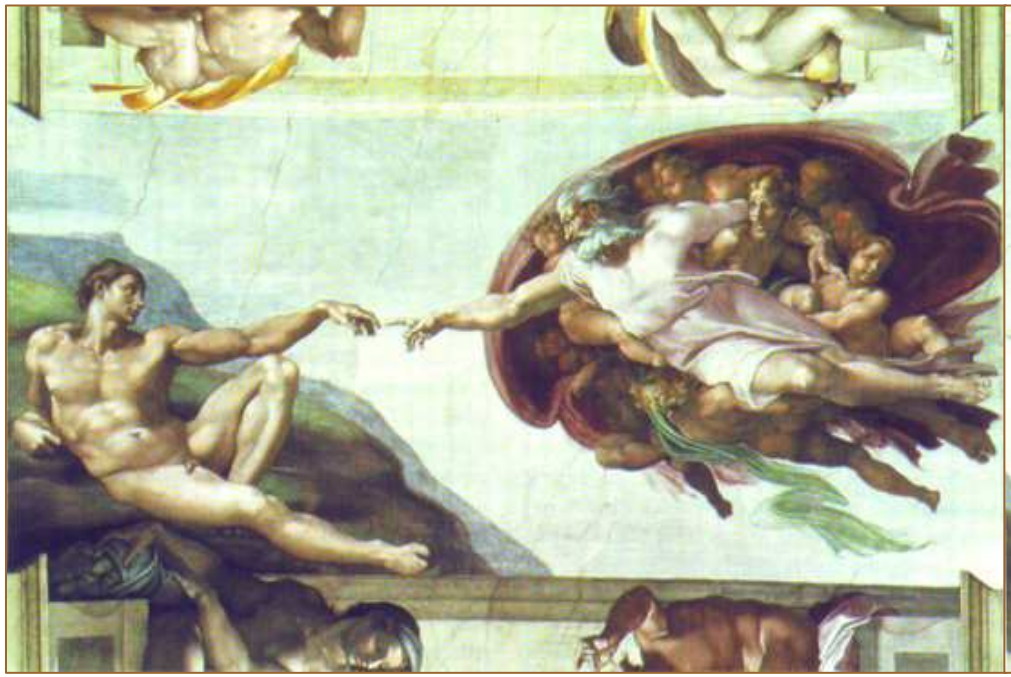
- Lat. *corpus amygdaloideum*
  Gr. αμυγδαλή, *amygdalē*, “almond”, “tonsil”
- Location – deep within the medial temporal lobes
- Amygdala nuclei:
  - ✓ corticomedial nuclear group – basal ganglia
  - ✓ basolateral nuclear group:
    - ➢ lateral amygdaloid nucleus
    - ➢ basal amygdaloid nucleus
    - ➢ accessory basal amygdaloid nucleus
  - ✓ central nucleus, medial and lateral
- Functions:
  - ✓ fear reactivity and other emotional functions
  - ✓ feeding
  - ✓ sexual behavior



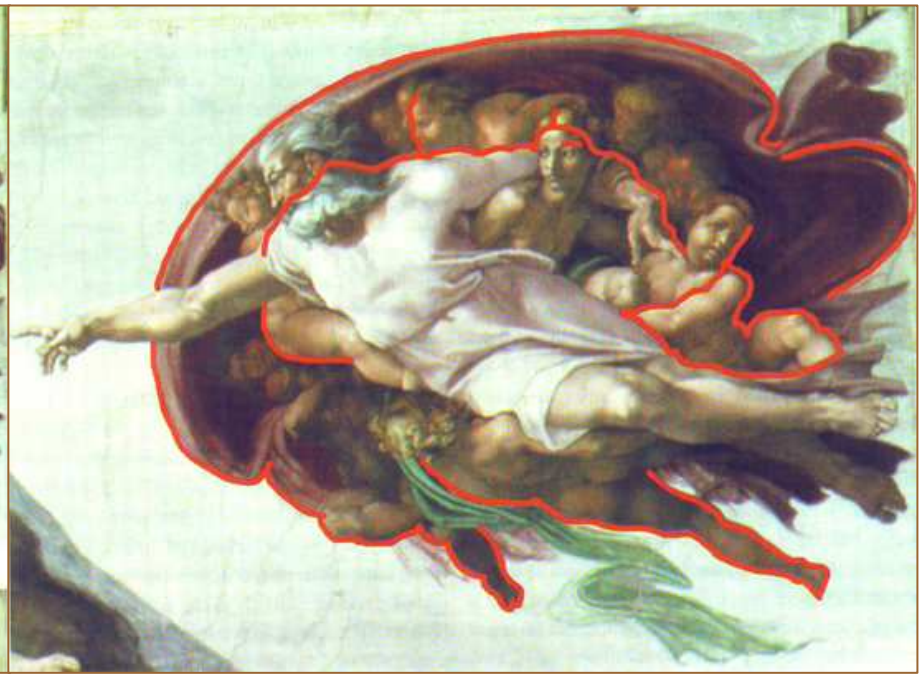




Localization of cerebral functions

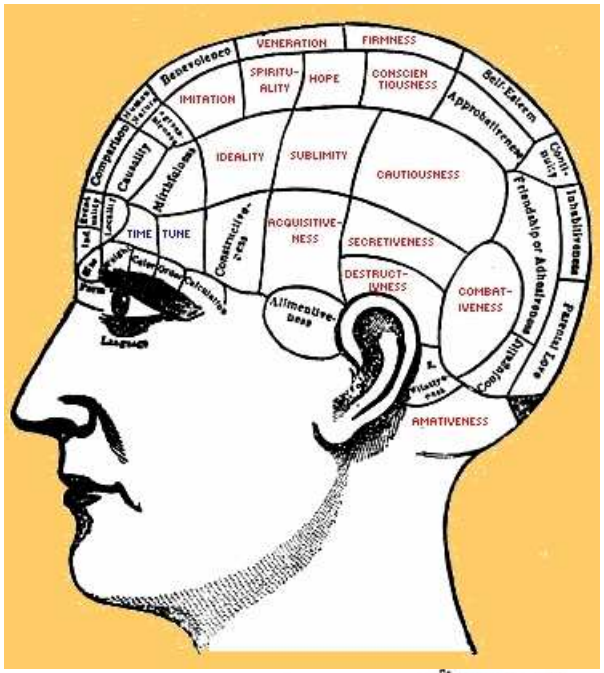


Michelangelo's *Creation of Adam*
(1508-1512)



Meshberger's interpretation
JAMA 264:1837-1841, 1990

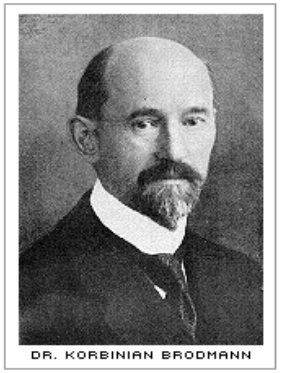
Cytoarchitectural maps



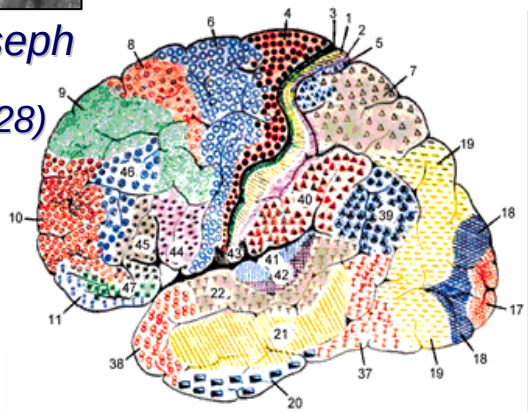
Franz Joseph Gall (1758-1828)

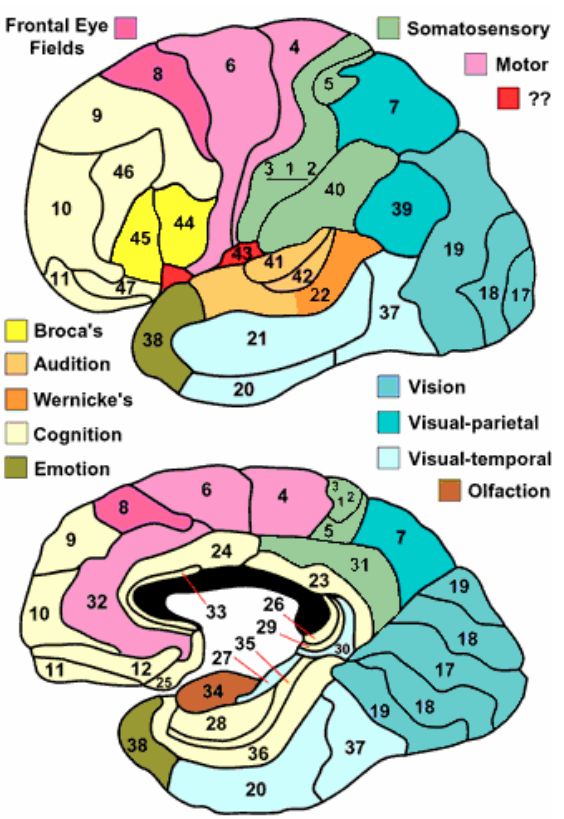
Schädellehre, Phrenology, 1796
Gr. *φρήν, phrēn*, "mind";
λόγος, logos, "knowledge"

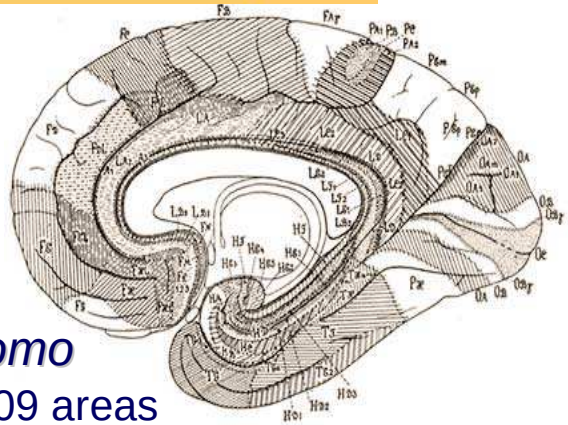
Campbell (1905) – 20 areas



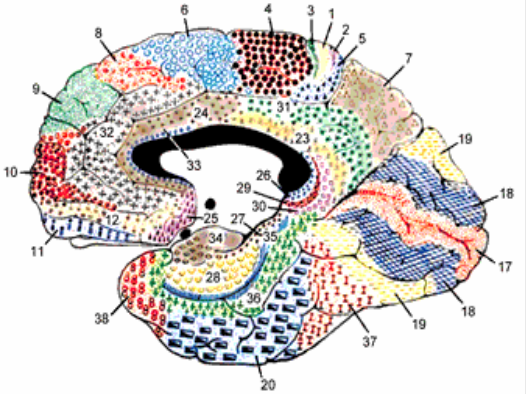
Brodmann (1909) – 52 cytoarchitectural areas





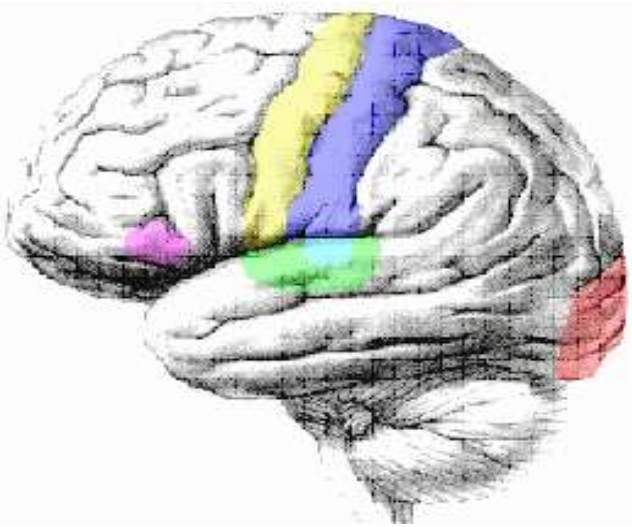


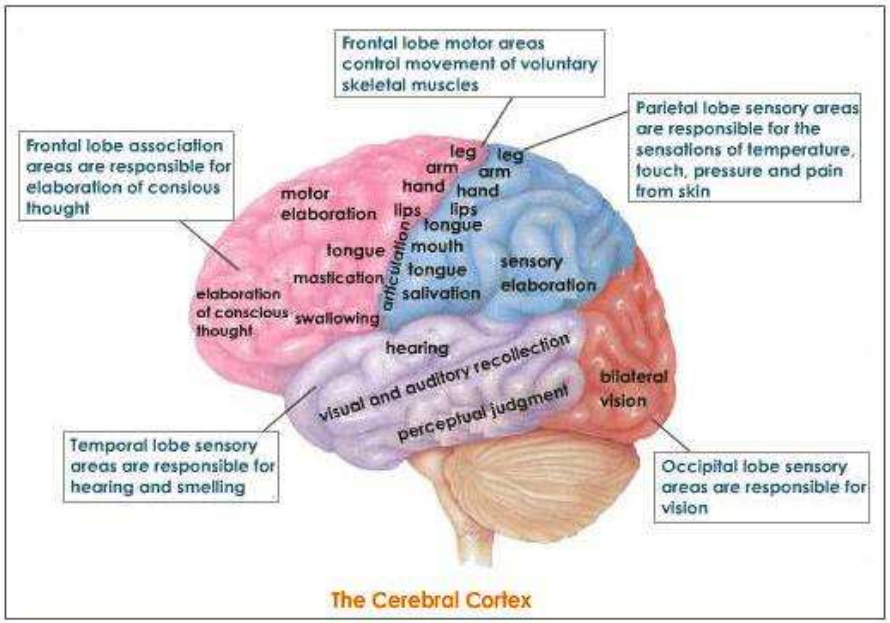
von Economo (1925) – 109 areas



Functional differentiation of the cerebral cortex

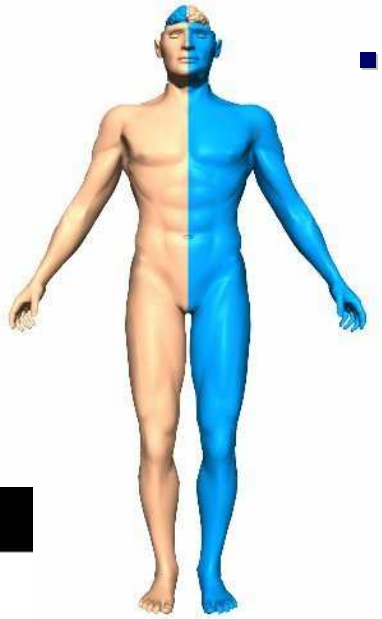
- Main cortical areas:
  - ✓ Sensory areas ⇦ afferent projections
  - ✓ Motor areas ⇨ efferent projections
  - ✓ Associational (‘silent’) areas
  - ✓ ‘Visuopsychic’ cortex



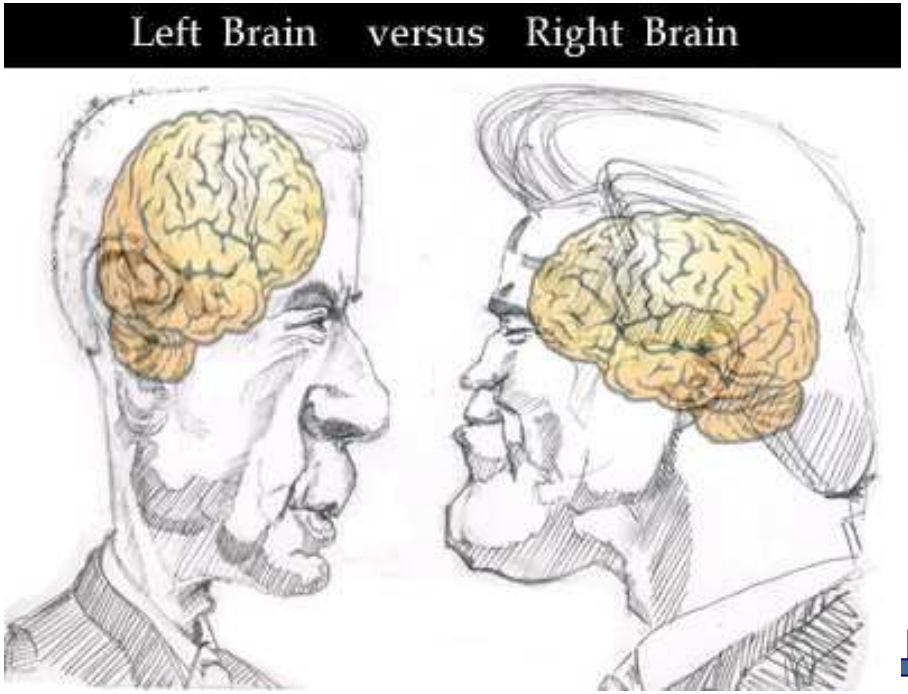


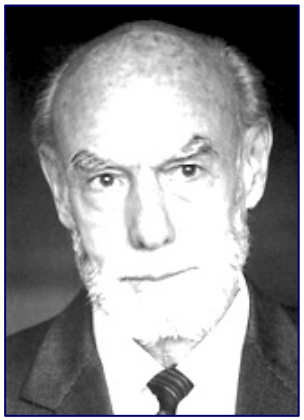
Cerebral asymmetry (hemispheric dominance)

- **Left hemisphere**:
  - ✓ verbal
  - ✓ linguistic description
  - ✓ mathematical
  - ✓ sequential
  - ✓ analytical
  - ✓ direct link to ‘consciousness’



- **Right hemisphere**:
  - ✓ almost non-verbal
  - ✓ musical
  - ✓ geometrical
  - ✓ spatial comprehension
  - ✓ temporal synthesis
  - ✓ link to ‘consciousness’?



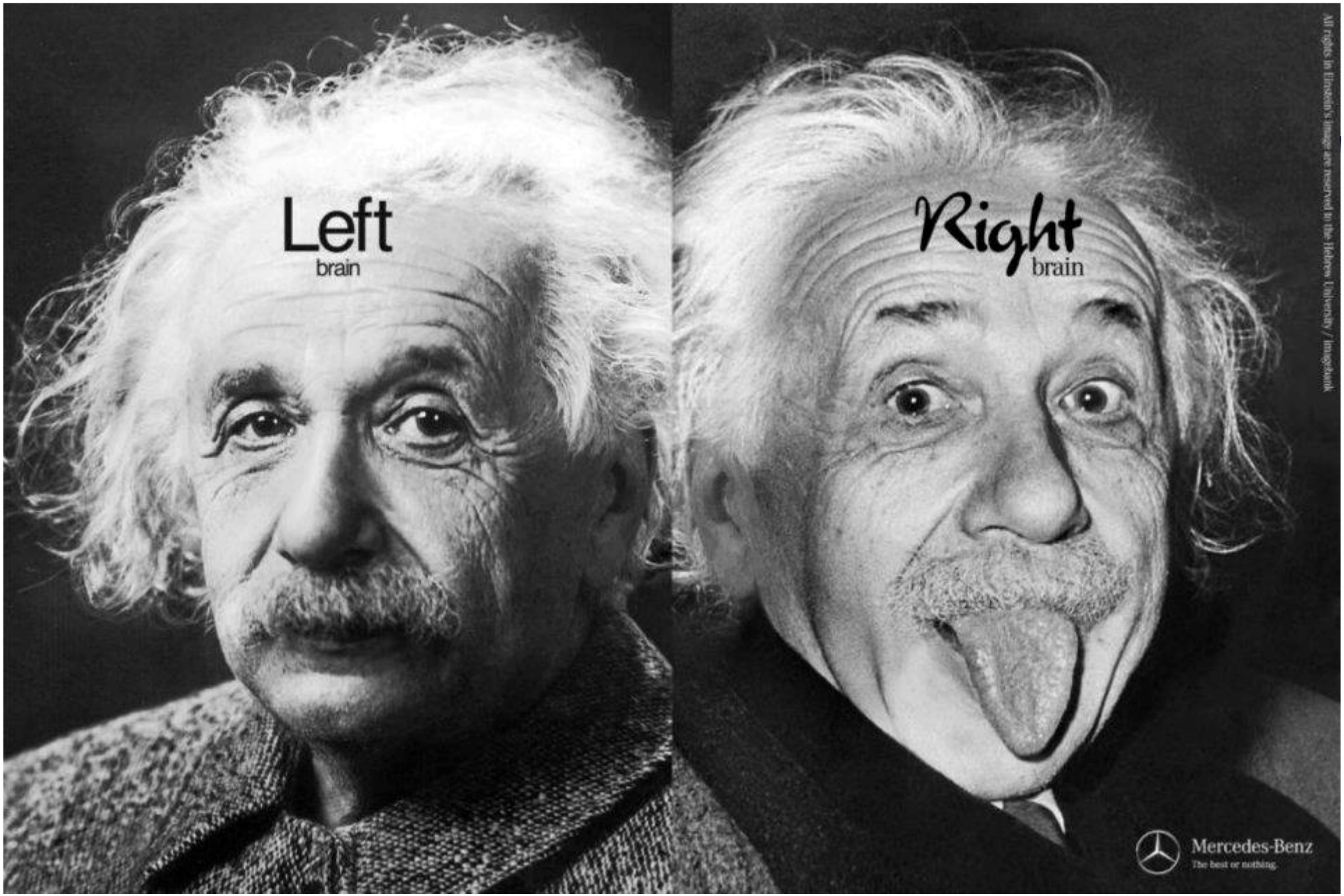


Roger W. Sperry – ‘’split-brain”

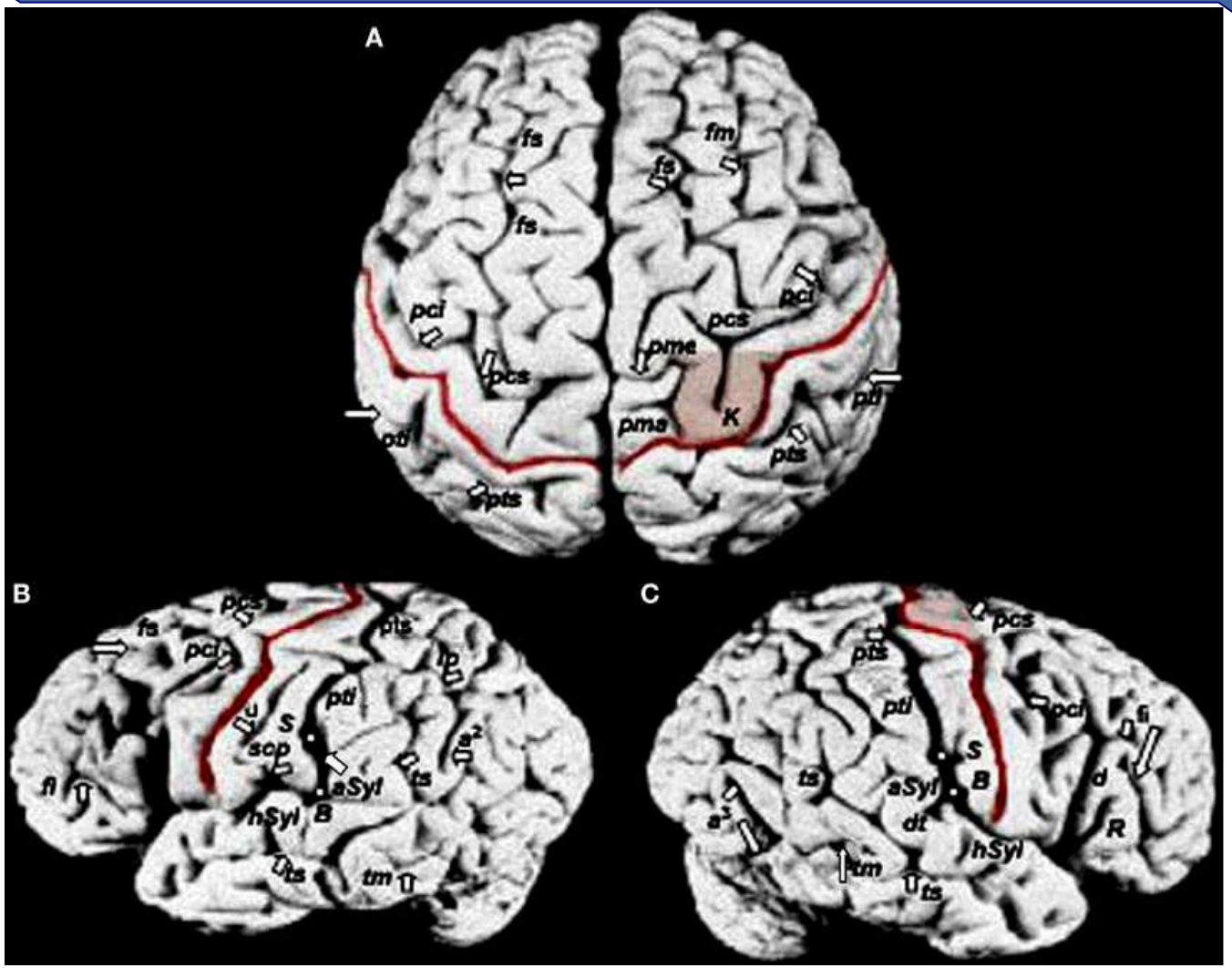
Nobel Prize in Medicine or Physiology 1981
"for his discoveries concerning the functional specialization of the cerebral hemispheres"

Prof. Dr. Nikolai Lazarov


Left
brain
I am the left brain.
I am a scientist. A mathematician.
I love the familiar. I categorize. I am accurate. Linear.
Analytical. Strategic. I am practical.
Always in control. A master of words and language.
Realistic. I calculate equations and play with numbers.
I am order. I am logic.
I know exactly who I am.
Right
brain
I am the right brain.
I am creativity. A free spirit. I am passion.
Yearning. Sensuality. I am the sound of roaring laughter.
I am taste. The feeling of sand beneath bare feet.
I am movement. Vivid colors.
I am the urge to paint on an empty canvas.
I am boundless imagination. Art. Poetry. I sense. I feel.
I am everything I wanted to be.
Mercedes-Benz
The best or nothing.


Left
brain
Right
brain
All rights in Einstein's image are reserved to the Hebrew University / imagestalk
Mercedes-Benz
The best or nothing.

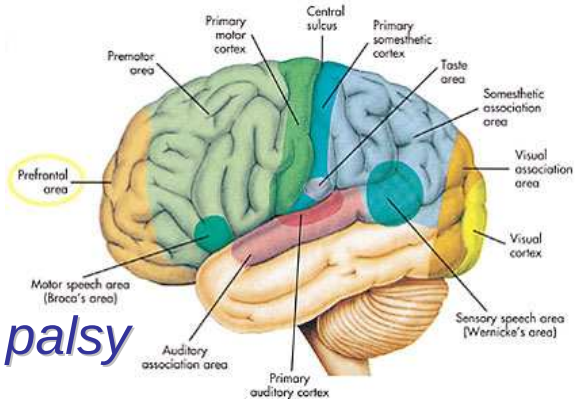
An old brain with new tricks



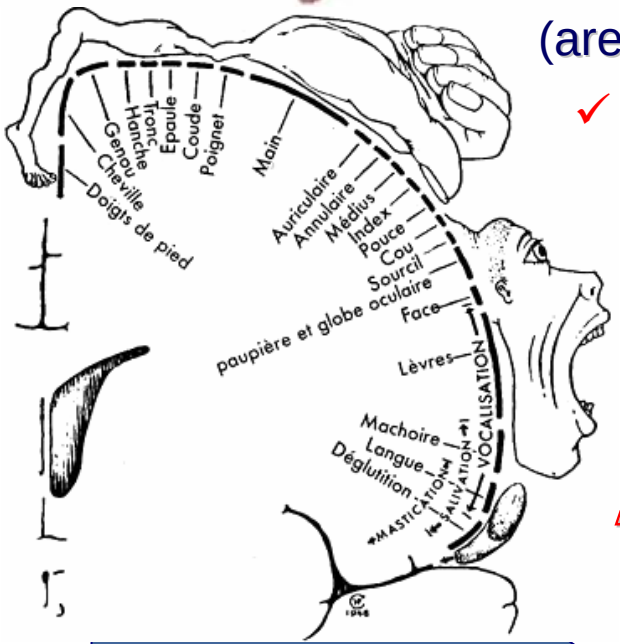
Dean Frank: New Information about Albert Einstein's brain
Front. Evol. Neurosci. 1:3, 2009

Somatomotor areas

- primary somatomotor area (M-I) = primary (precentral) motor cortex (area 4 of *Brodmann*):
  - ✓ *gyrus precentralis*
  - ✓ *lobulus paracentralis* ⇨ *paresis and palsy*



- second somatomotor area = premotor cortex (area 6 and parts of areas 8, 44, 45): ⇨ *apraxia*
  - ✓ most caudal parts of *gyri frontales sup., med. et inf.*
    - supplementary motor area (M-II):
      - ✓ medial surface – medial part of area 6
        - ➢ between area 4 and cingulate gyrus
        - ➢ ahead of *lobulus paracentralis*

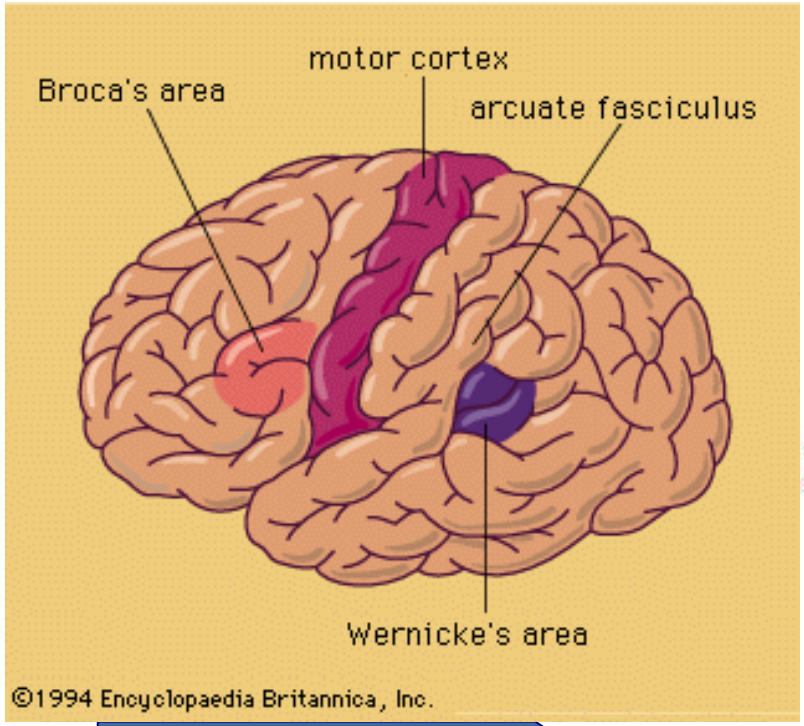


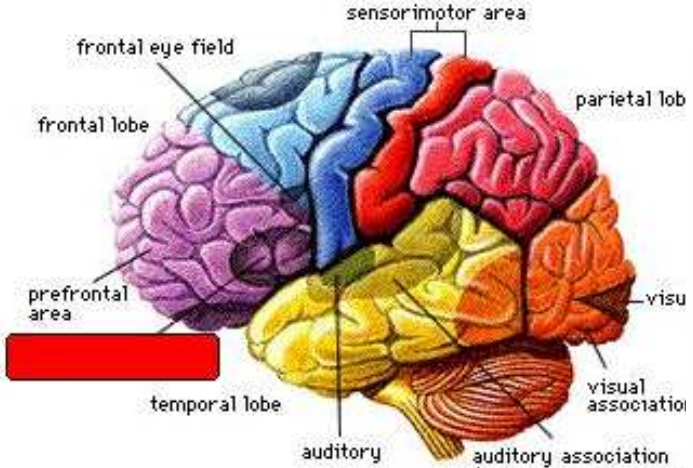
⇨ *"motor homunculus" (Latin: "little man") of Penfield and Rasmussen*

Somatomotor areas

Paul Broca, 1861
speech center

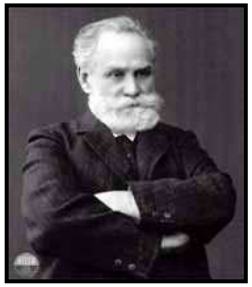
- frontal eye field – middle frontal gyrus
  "center for voluntary eye movements":
  - ✓ considerable (inferior) part of area 8
  - ✓ area 6 behind and probably area 9 in front
- second frontal eye field – anterior to the above
- motor speech area:
  - ✓ posterior part of the inferior frontal gyrus – area 44 and part of area 45 (*gyrus Brocae*)





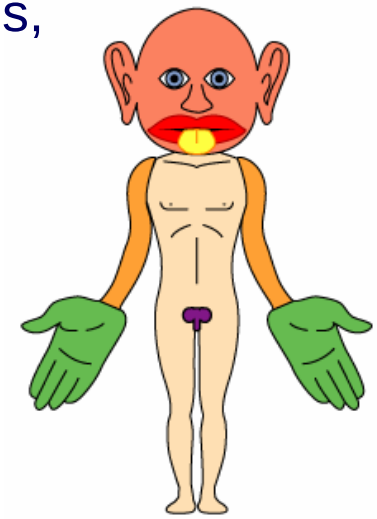
⇨ *motor aphasia (paralysis of speech in man)*
⇨ *agramatismus*

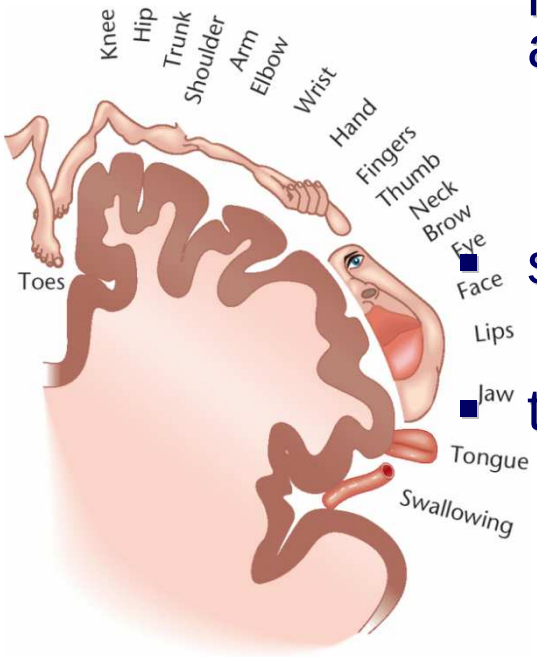
Somatosensory areas



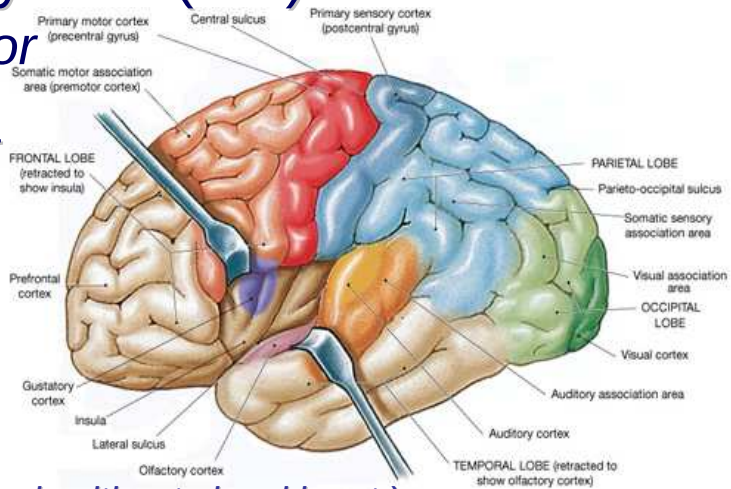
И.П. Павлов

- I.P. Pavlov – Pavlov's cortical irradiation hypothesis, *"cortical representations"* of sensory modalities
  - ✓ primary (first-order) areas
  - ✓ associative (second- and third-order) areas – involved in integration of incoming sensory information
    - primary somatosensory area (S-I) – areas 3, 1 and 2:
      - ✓ *gyrus postcentralis*
      - ✓ part of *lobulus paracentralis*
    - secondary somatosensory area (S-II) – area 5
      - ✓ *lobulus parietalis superior*
    - third somatosensory area (S-III) – area 7
      - ✓ between the primary and parainsular cortex





⇨ *"sensory homunculus" of Penfield and Rasmussen*



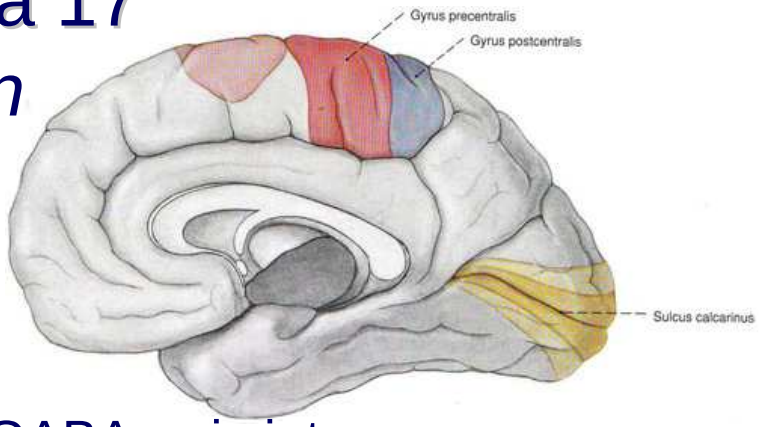
⇨ *tactile agnosia*

⇨ *astereognosis*

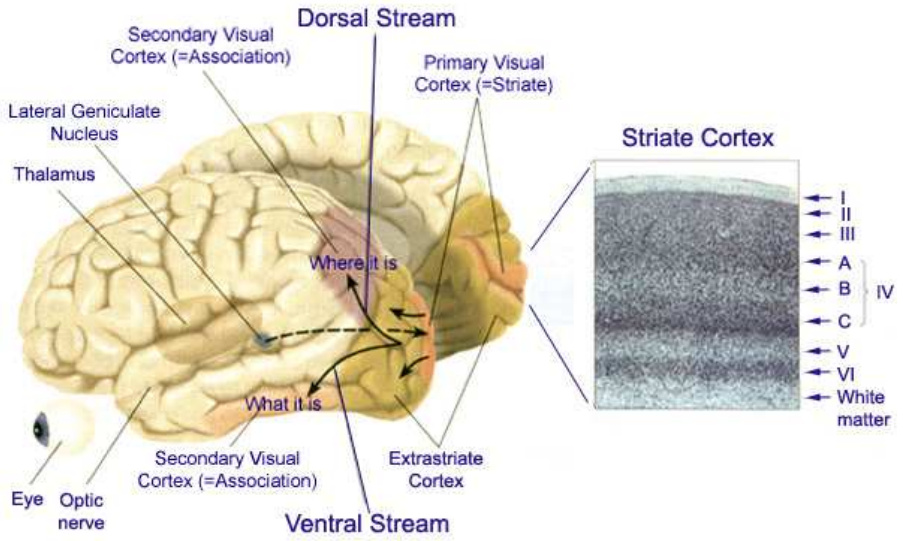
(inability to identify an object by touch without visual input)

Visual receptive areas

- primary visual cortex (V-I) – area 17
  calcarine sulcus ⇦ *optic radiation*
  - ✓ granular type cortex (koniocortex)
  - ✓ *area striata* (striate cortex)
    - ➢ 3% of cerebral surface area
    - ➢ 10% of cortical neurons – numerous GABAergic interneurons
  - ✓ visual agnosia – inability of the brain to make sense ("mentally blindness")



- secondary visual cortex (association areas):
  - ✓ in the occipital lobe
    - ➢ V-II – area 18
    - ➢ V-III – area 19

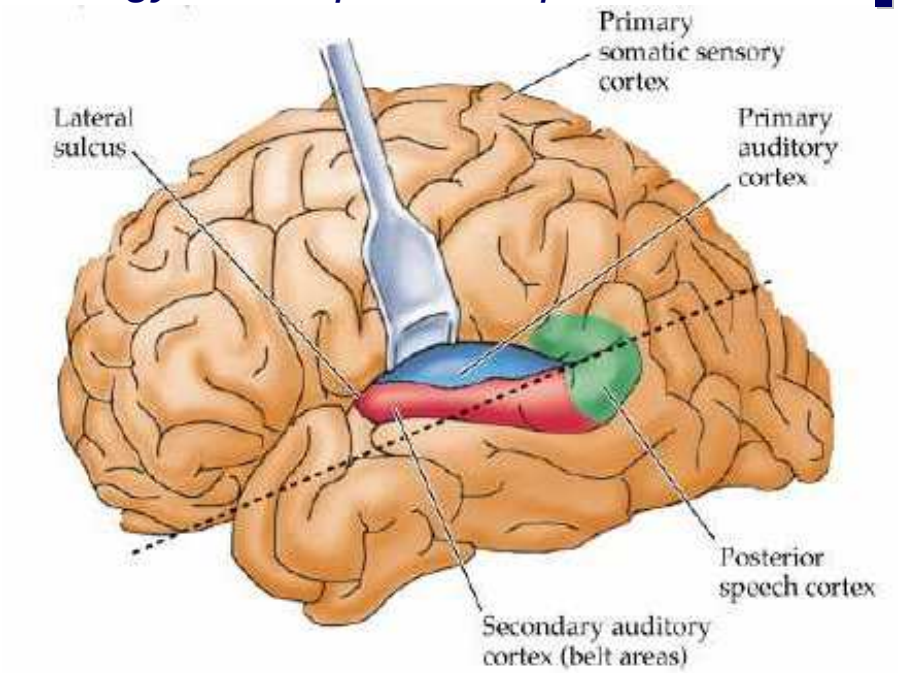


Auditory receptive areas

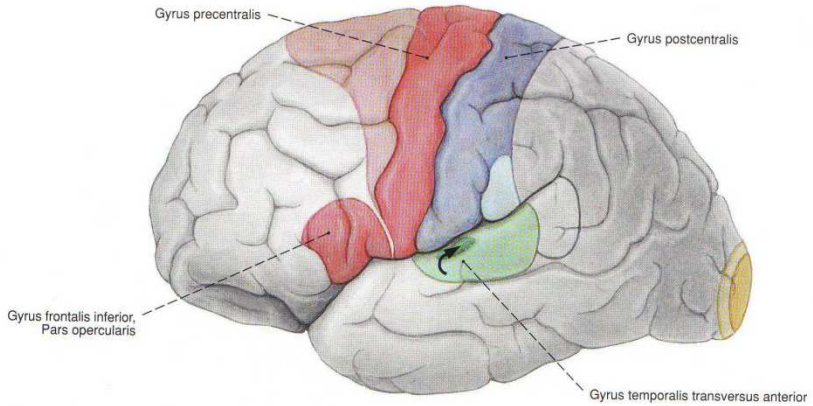
- primary auditory cortex (A-I) = area 41 ⇦ *acoustic radiation*
  - ✓ granular type cortex
  - ✓ upper part of *gyrus temporalis superior*
  - ✓ *gyri temporales transversi* (*Heschl's* gyrus)

⇨ *acoustic agnosia (word but not sound deafness)*

- secondary auditory cortex (A-II) = area 42; belt areas – association (second-order) auditory area:
  - ✓ *gyrus temporalis superior*

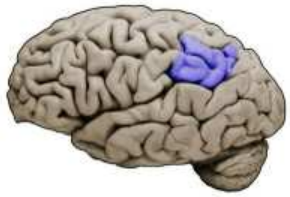


- tertiary auditory cortex (A-III) = area 21; association (third-order) auditory area:
  - ✓ between the first, second acoustic area and parainsular cortex

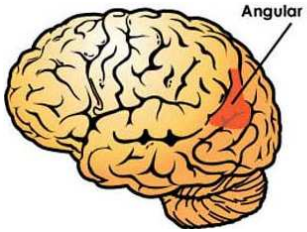


Gnostic areas

- supramarginal gyrus (area 40) – inferior parietal lobe:
  - ✓ involved in phonological and articulatory processing of words
  - ✓ *agraphia* (writing apraxia = inability to write)
  - ✓ *astereognosia*
  - ✓ *apraxia* (inability to execute a normal volitional act)



- angular gyrus (area 39):
  - ✓ written word is translated to internal monologue
  - ✓ *alexia* ("word blindness") – inability to recognize written words or the meaning of words

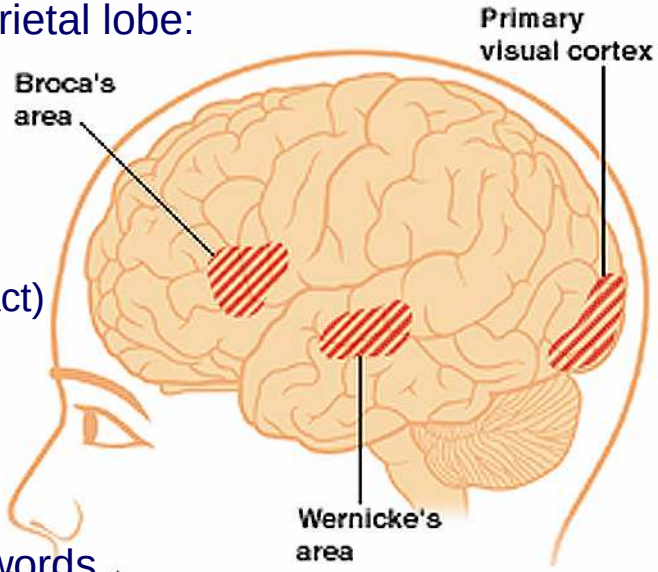


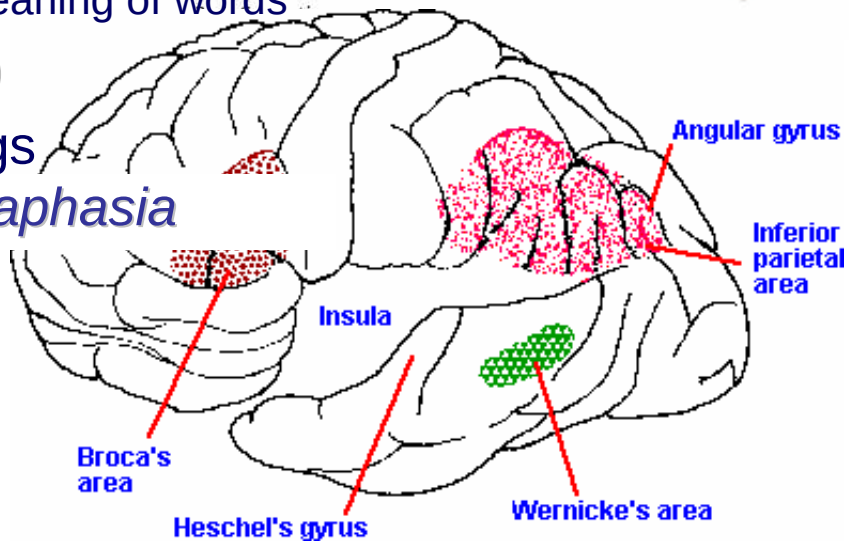
- speech area of *Wernicke* (area 22)

processes dominant word meanings (semantic processing): ⇨ *sensory aphasia*

  - ✓ posterior section of the superior temporal gyrus
  - ✓ *gyrus supramarginalis*
  - ✓ *gyrus angularis*

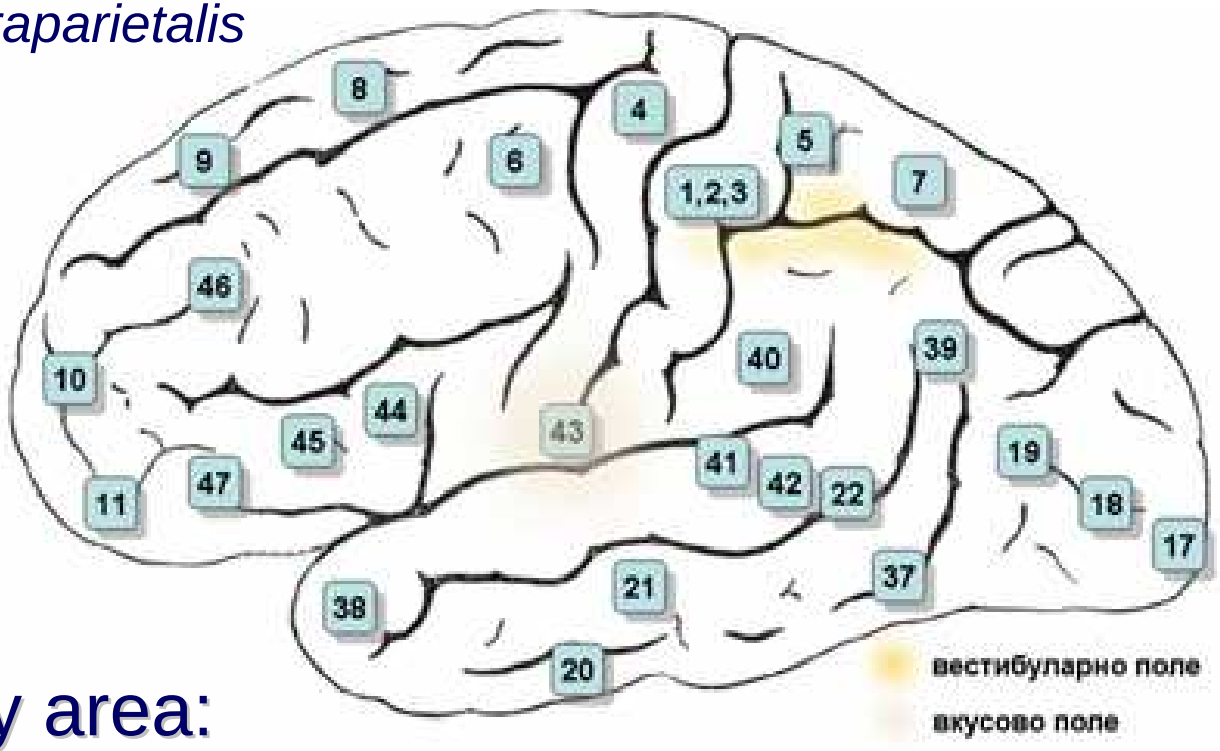
C. Wernicke 1874





Other cortical areas

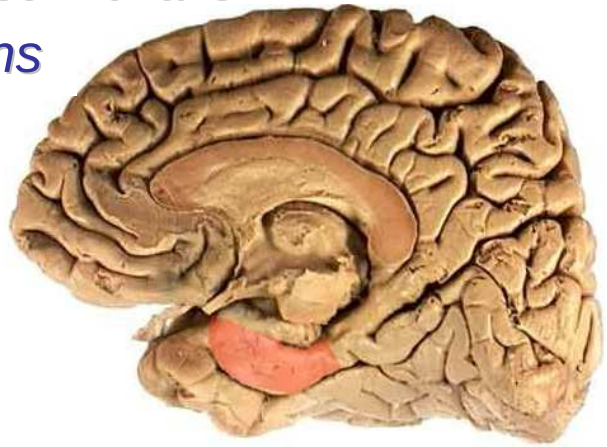
- Vestibular area:
  - ✓ *gyrus postcentralis* ⇨ *sensations of turning movements and dizziness*
  - ✓ *sucus intraparietalis*

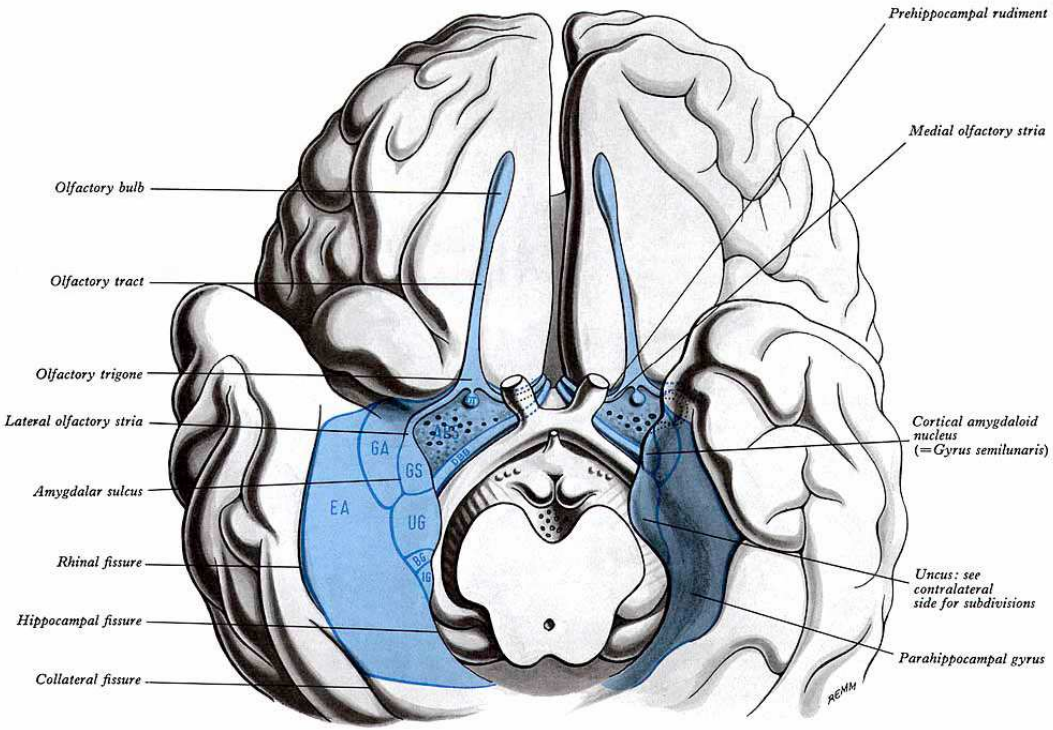


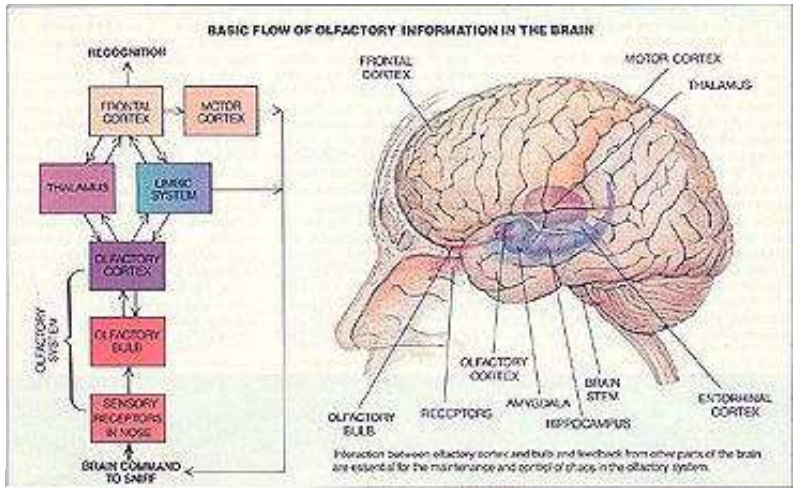
- Gustatory area:
  - ✓ the lowest part of *gyrus postcentralis*, parietal operculum (area 43)
  - ✓ parainsular cortex? ⇨ *loss of gustatory sensations*
    ⇨ *gustatory hallucinations*

Olfactory cortex (piriform lobe)

- primary olfactory cortex:
  - ✓ prepiriform cortex – lateral olfactory gyrus ⇨ gyrus ambiens
  - ✓ periamygdaloid area – lateral olfactory stria ⇨ gyrus semilunaris
- secondary olfactory cortex: ⇨ *olfactory hallucinations*
  - ✓ entorhinal area, cranial part of parahippocampal gyrus

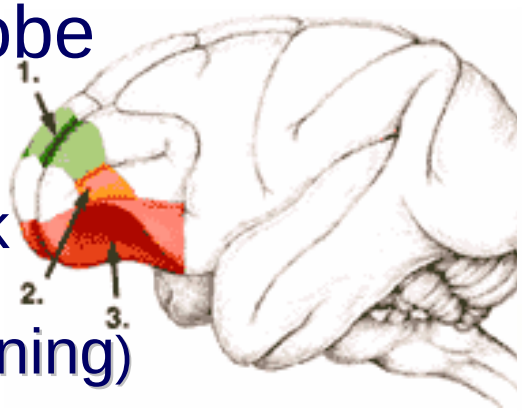




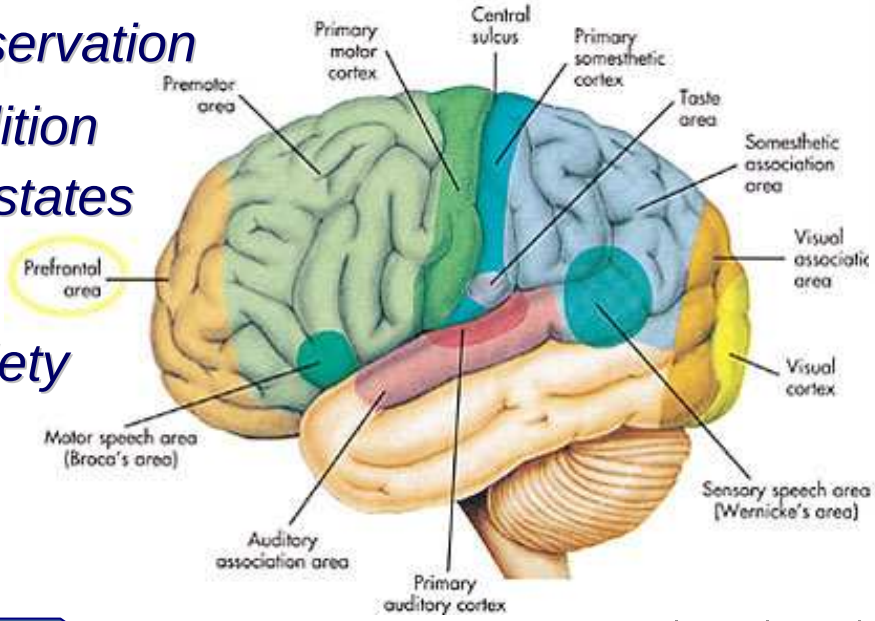


Prefrontal cortex

- rostral part of frontal lobe (areas 9-12):
  - ✓ ability to perform a task



- in bilateral ablation (sectioning) and frontal lobotomy (leucotomy):
  - ✓ *intellectual preservation*
  - ✓ *successful abolition of obsessional states*
  - ✓ *pain relief*
  - ✓ *removal of anxiety and fear*

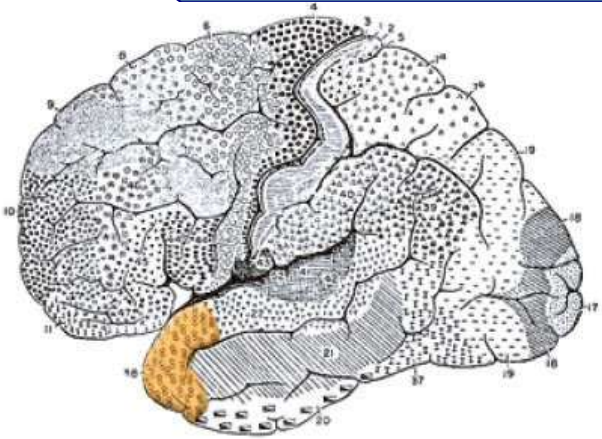


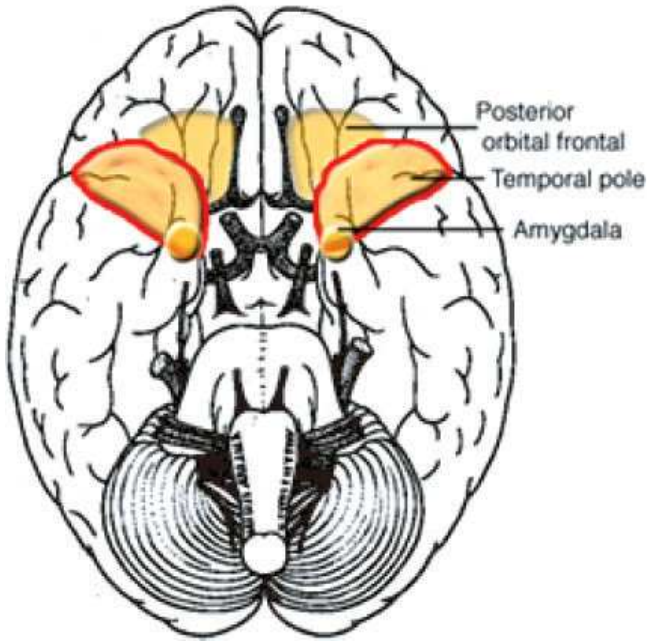
The researchers found that the relationship between cortex thickness and IQ varied with age, particularly in the prefrontal cortex (yellow), seat of abstract reasoning, planning, and other "executive" functions.

what makes us humans

Temporo-polar ("psychic") cortex

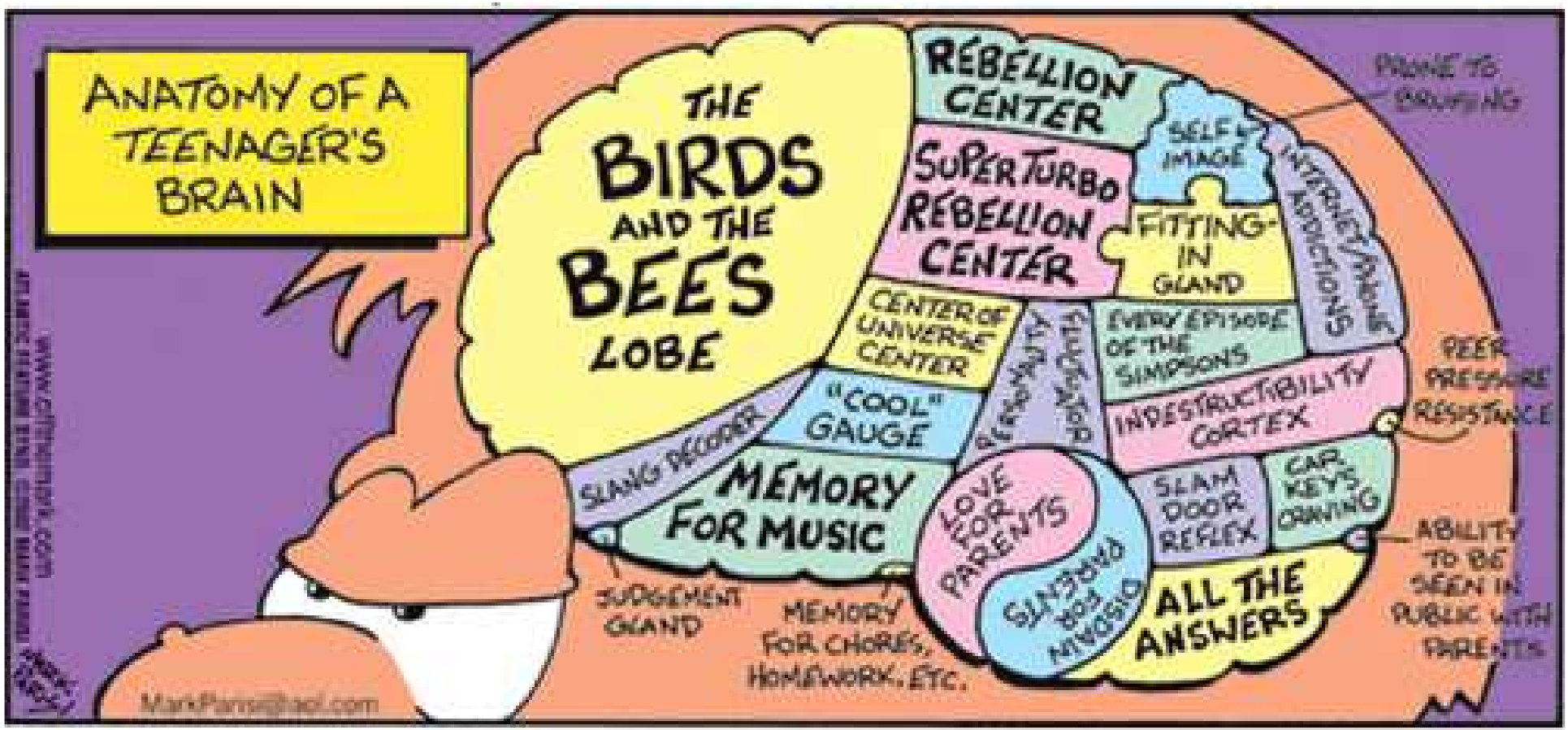
- Temporal pole – a paralimbic region:
  - ✓ part of an extended limbic system
  - ✓ role in both social and emotional processes, including face recognition
  - ✓ integration of emotion with perception
  - ✓ recognition from auditory or visual cues ⇨ visual and acoustic hallucinations





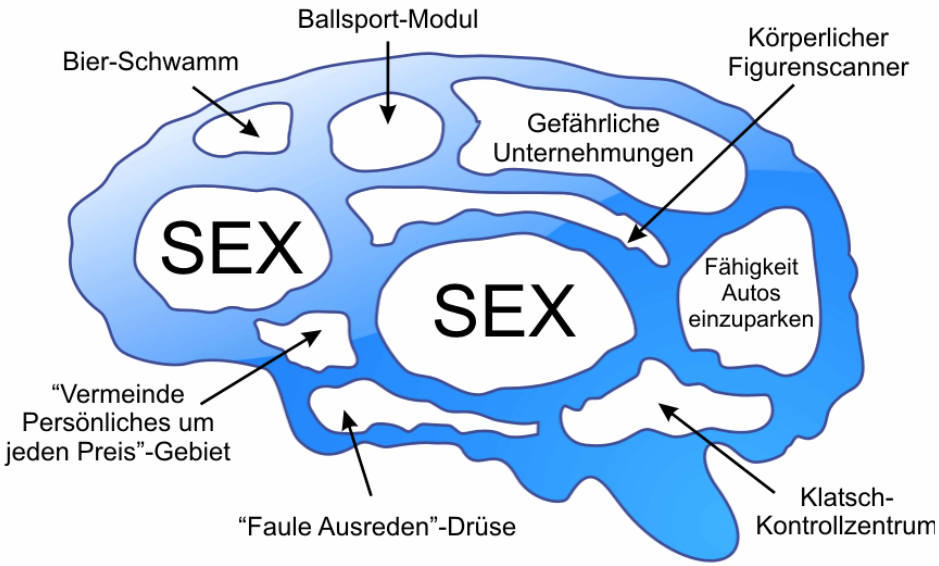
Homer J. Simpson

Age-related functional specialization



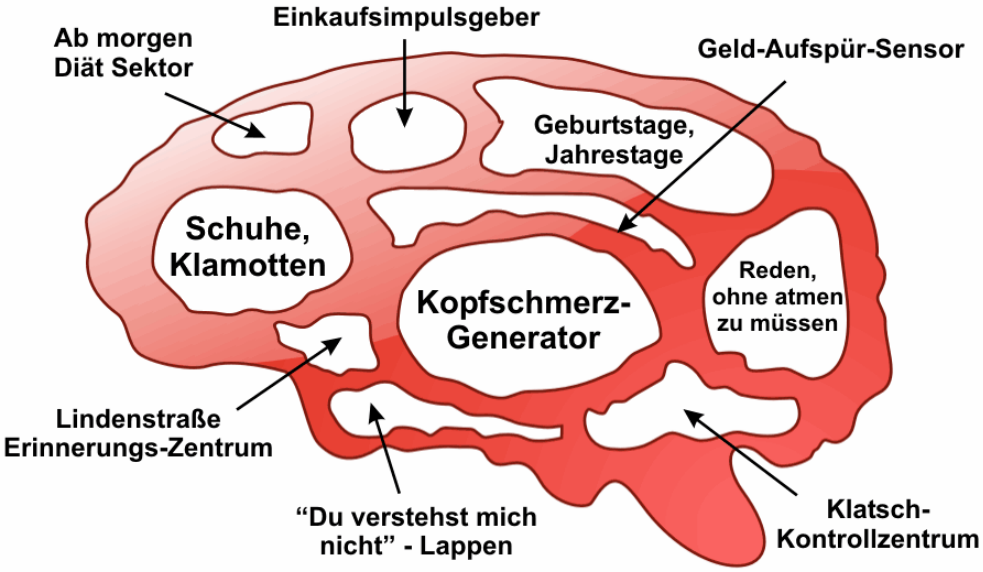
Sex differences in the cerebrum

Das männliche Gehirn



Männliche Hirnregionen, die eng miteinander verbunden sind: "Bier-Schwamm", "Sex" und "Faule Ausreden"

Das weibliche Gehirn



Hat ER ihren Einkaufsimpuls befriedigt, unterdrückt SIE eventuell auch mal den "Du verstehst mich nicht" - Reflex

Thank you…