CEREBRAL LOCALIZATION

PRESENTED BY:
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Definition

1. The diagnosis of the location in the cerebrum of a brain lesion, made either from the signs and symptoms manifested by the patient or from an investigation modality.

2. The mapping of the cerebral cortex into areas, and the correlation of these areas with cerebral function.
Functional Localization of Cerebral Cortex --- HISTORY

- Phrenology of Gall (1781) and Spurzheim

  **Phrenology**: Analysis of the shapes and lumps of the skull would reveal a person’s personality and intellect. Identified 27 basic faculties like imitation, spirituality.

- **Paul Broca** (1861): Convincing evidence of speech laterality

  “Tan”: Aphasic patient

- **Carl Wernicke** (1874):
  - Temporal lesion disturbs comprehension.
  - Connectionism model of language
  - Predicated conduction aphasia
Experimental evidences
Fritsch and Hitzig (1870) --- motor cortex
von Gudden (1870) ---- visual cortex
Ferrier (1873) ---- auditory cortex

**BASED ON CYTOARCHITECTONIC STUDIES**

**Korbinian Brodmann (1868-1918):**
- Established the basis for comparative cytoarchitectonics of the mammalian cortex.
- 47 areas
- most popular

- Vogt and Vogt (1919) - over 200 areas
- von Economo (1929) -- 109 areas
- **HARVEY CUSHING**: Mapped the human cerebral cortex with faradic electrical stimulation in the conscious patient.

- **PENFIELD & RASMUSSEN**: Outlined the motor & sensory Homunculus.
Brodmann’s Classification
Cerebral Dominance (Lateralization, Asymmetry)

**Dominant Hemisphere (LEFT)**

- Language
  - speech, writing
- Analytical and mathematical skills
- Temporal sequencing of stimuli

**Non-dominant Hemisphere (RIGHT)**

- Spatial Perception (3D subject)
- Singing
- Playing musical instrument
CLINICAL

- Lobar signs
- Clinical syndromes
  - Aphasia
  - Apraxia
  - Agnosia
  - Anopia
Frontal Lobe Signs

- Impaired memory
  - Recent
- Procedural defects
- Emotional lability
- Senseless joking
- Abulia

Pathologic Laughter And Crying: (Lesions of bilateral internal capsule + basal ganglia; substantia nigra, cerebral peduncles, and hypothalamus; corticobulbar fibers,)

Mr. Phineas Gage
Frontal Lobe Signs

- **Alien Hand Syndrome**
  - Hand contra lateral to lesion performs purposeful movements against will of patient
  - Lesion in Dominant Frontal Lobe (SMA, anterior cingulate gyrus and medial prefrontal cortex)

- **Magnetic Gait**
  - Mesial Frontal lesion

- **Salutatory Seizure**
  - Origin in SMA

- **Akinetic Mutism**
  - B/L Mesial Frontal Lesion

- **Paratonia**

- **Primitive Reflexes**
Frontal Lobe Signs

- **Pseudobulbar Palsy**
  - Opercular Syndrome

- **Broca’s Aphasia**
  - Lesions in Left frontoparietal opercular region
  - Speech and writing are impaired
  - Telegraphic speech

- **Pure Agraphia**
  - Affection of the posterior part of the
  - Left second frontal gyrus
  - (Exner’s area)
Frontal Lobe Signs

- **Executive Function Loss**
  1. **Orbitofrontal syndrome**
     - Disinhibited
     - Impulsive
     - Poor judgment and insight
  2. **Frontal convexity syndrome**
     - Apathetic
     - Aggressive
     - Poor word list generation
  3. **Medial frontal syndrome**
     - Akinetic
     - Incontinent
Parietal Lobe

Elemental Somatosensory Disturbances

- **Pseudothalamic sensory syndrome**
  - Lesion of parietal operculum, posterior insula
  - Impairment of elementary sensation

- **Cortical sensory syndrome**
  - Astereognosis,
  - Graphesthesia, position sense impaired
Parietal Lobe

Disturbances of Body Schema and Spatial Relationships

- Common with Right Hemisphere Lesions
- Anosognosia
- Phantom limb
- Constructional apraxia
- Geographical apraxia
- Dressing apraxia
- Hemineglect

Dressing apraxia
Disturbances of Sensorimotor Integration and Movement Execution

- Ideomotor apraxia
  - Failure to perform a *pantomime*
  - Most severe with lesions in the region of Left intraparietal sulcus
- Left frontal lesions
  - buccofacial apraxia, right hemiparesis, and left limb apraxia
- Left parietal lesions
  - buccofacial apraxia and bilateral limb apraxia
Temporal lobe

Hearing loss

- Auditory agnosia
  - Hearing intact
  - Sounds not recognized
  - Temporal lobe damage U/L or B/L

- Pure word deafness
  - B/L Temporal Cortical Lesion

- **Left** Hemispheric Damage Impaired Discrimination of *Words, lyrics*

- **Right** Hemispheric Damage Impaired Discrimination of *Musical sounds*
Temporal lobe

- **Complex hallucinations**
  - Otoscopic phenomena
  - Illusory phenomena (micropsia, metamorphopsia)
- **Uncinate fits**
  - Olfactory hallucinations
- **Gustatory Hallucinations**
  - Temporo - Parietal Seizures
- **Déjà vu, jamais vu, Déjà vecu, jamais vecu**
  - Neocortex of temporal lobe
- **CPS**
Aphasias

Sensory Language Area (Wernike's area) --- 22, 39, 40

Receptive Aphasia - area 22
• defect in comprehension
• good spontaneous speech

Anomic Aphasia - area 38, 20, 21
• word finding difficulty

Jargon aphasia
• fluent, but unintelligible jargon
• 39 (supramarginal gyrus), 40 (angular gyrus)
Aphasias

Superior Longitudinal Fasciculus
- Conduction Aphasia
  - good comprehension, good spontaneous speech
  - poor repetition, poor response

Motor Language Area (Broca’s area) --- 44, 45
- Motor Aphasia
  - good comprehension, no speech
Occipital Lobe

- **Simple Hallucinations**
  - Infero Medial Occipital Disease
  - Migraine (fortification)
  - Seizures (multicolored)

- **Hemianopia with/without Macular Sparing**
  - Congruent
Visual Agnosias

- Visual agnosia
- Alexia without agraphia
- Alexia with agraphia
- Gerstmann Syndrome:
  - Agraphia
  - Right-Left confusion
  - Acalculia
  - Finger agnosia

- Achromatopsia
- Color agnosia
- Prosopagnosia

Face and object recognition areas
ELECTRPHYSIOLOGICAL

ELECTROENCEPHALOGRAPHY (EEG)

ELECTROCORICOGRAPHY (ECoG)
Plain radiograph
RADIOLOGICAL

MRI
Positron Emission Tomography (PET)

- $\text{H}_2\text{ }^{15}\text{O PET}$
  - Hemodynamic changes
- FDG PET
  - Cerebral Metabolism
MAGNETOENCEPHALOGRAPHY (MEG)

- Noninvasive
- Records Magnetic field changes due to neuronal activity
Functional MAGNETIC RESONANCE IMAGING (fMRI)

Based on the concept of **Blood Oxygenation Level-dependent Contrast (BOLD)**

- Oxyhemoglobin is diamagnetic (like biological tissue).
- Deoxyhemoglobin (dHb) is paramagnetic
  induce susceptibility effect around dHb
Anisotropic Diffusion Tensor Imaging (Tractography)

Direction of maximum diffusivity of water corresponds to axis of White Matter tracts

- Displacement
- Edema
- Infiltration
- Destruction
INTRAOPERATIVE LOCALIZATION IN NEUROSURGERY
INTRAOPERATIVE ULTRASOUND (IOUS)
• Sonographically Guided Procedures in the Brain
• Intraoperative Doppler Ultrasound
• 3-D Transcranial Ultrasound
• Contrast Enhanced Transcranial Ultrasonography
STEREOTACTIC LOCALIZATION:

- FRAME BASED

- FRAMELESS
Intraoperative / Mobile Ct Scan:
Intraoperative MRI:

- Also k/a "BRAINSUITE"
CORTICAL MAPPING:

Cortical Surface Mapping
WADA Procedure

(a)

Left common carotid artery

Sodium Amytal

Dye for angiography
EXPERIMENTAL

- **Single Unit Recording**
  - Animal studies
  - **Advantage**: great spatial and temporal resolution
  - **Disadvantage**: sampling only a very small fraction of a functional neural system

- **Transcranial Magnetic Stimulation**
  - Coil placed over target brain region
  - **Lesion**: strong field
  - **Excitation**: mild field
  - Cognitive failures recorded

- **Optical imaging**
Split-brain

- Corpus callosotomy
Utility of Cerebral Localization

1. Pre-operative Planning
2. Create a Road Map of Brain Depicting Eloquent “No-Go” areas as well as potential functional targets
3. Increasing precision of resection
4. Development of Minimally invasive techniques
5. Recognition of concept of plasticity of brain
THANK YOU