Function of Cerebral Cortex

This answer is oriented to dentistry students.

Physiological anatomy of the cerebral cortex

- Total area of 0.25 m2, giri, sulci, fissures
- Approximately >1010 neurons
- **Pyramidal neurons**
  - Largest cortical cells
  - Dendrites in different layers
  - Projecting neurons
  - Excitatory (Glutamate, Aspartate NTs)
- **Stellate (granule) neurons**
  - Local circuit neurons
  - Often send a projecting axon
  - Spiny stellate neurons → Excitatory
  - Smooth stellate neurons → Inhibitory (GABA)
- **Fusiform cells**
  - Elongated cell
  - Local circuit neurons

Stratification of the cerebral cortex

- Most incoming specific sensory signals terminate in **layer IV**
- Most of output signals leave the cortex from neurons in
  - **Layers II & III** (corticocortical)
  - **Layer V** (to brainstem, striatum and the spinal cord)
  - **Layer VI** (corticothalamic)
- Layers I, II and III perform most of the intracortical association functions
- Cortical columns
  - Neurons along a line perpendicular to the cortical surface have similar response properties and receptive fields

Sensory cortex → IV (mainly)

Primary motor → V, VI (mainly)

Association cortex → in between sensory & primary

A== Function of specific cortical areas ==

- **Primary sensory areas**
  - Somatic
  - Visual
  - Auditory
  - For experience of sensation
- **Secondary sensory areas**
  - Corticocortical input
  - Make sense out of the specific sensory signals (interpreting the shape, texture of a object, stimulating the cutaneous receptors; light intensity or color; combination and sequence of tones)
- **Primary motor area**
  - Connected with specific muscles
- **Secondary motor area**a4
  - Programming of the motor action
  - Collaboration with basal ganglia & cerebellum

The association cortex

- Most of the cortex is association cortex
- Cortical areas that receive and analyze signals from multiple regions of the cortex and from some subcortical structures

Parieto-occipito-temporal association area

- Polymodal sensory high level analysis and interpretation of signals (visual, auditory and somatosensoric inputs)
- Memory functions
  - Interpretation of sensory information for conscious perception and language

- Functions
  - **Spatial coordinates**
    - Of the body and surroundings (lesion – loss of the recognition, orientation over one's own body – contralateral neglect
  - **Language comprehension**
    - Auditory processing of words (Wernicke's area) + intelligence
  - **Visual processing of written words**
    - Lesion → dyslexia, word blindness)
  - **Naming of objects**
    - Auditory input (names)
    - Visual input (nature of the object)

The prefrontal association area

Works in close association with the motor cortex

- Information on the spatial coordinates of the body
- Planning of effective movements
- Neuronal circuitry for word formation

The Limbic Association

- Behavior
- Emotions
- Motivation

The specialization of hemispheres

Functions that require extensive intracortical connectivity may become lateralized (the capacity of interhemispheric connections is much lower)

- **Left hemisphere** specialized on the
  - Precise motor movements of hands
  - Word formation and language
  - Logical interpretation of the processed information
  - Rational and analytical thinking
  - Mathematical amplitude
- **Right hemisphere** is specialized on the
  - Complex and parallel procession of information
  - Nonverbal auditory experience
  - Non verbal visual
  - Non verbal communication
  - Emotional, nonverbal, intuitive thinking
- Evidence of hemispheric asymmetry at birth
  - Physical structure of the brain
  - Hand preference
  - Responses to visual auditory stimuli
- In infancy, different stimuli seem to activate one hemisphere only, or at least one hemisphere more that the other
- **Corpus callosum** is structurally and functionally incomplete until around two years of age
- The process of hemisphere specialization ends around the age of 12 years.
- Functional specialization of hemispheres (**lateralization**) coincides with the period of **higher plasticity** of neuronal circuits

Planum Temporale

- A section of the temporal cortex that is larger in the left hemisphere in approximately 65% of the population. This difference in size is apparent at age 3 months in humans
- Children with the biggest ratio of left to right planum temporale performed better in language tests

Links

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Sources

Prof. Jaroslav Pokorný