

Functional Neuroanatomy and Traumatic Brain Injury – The Frontal Lobes

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Outline

- TBI
- Mechanisms of Injury
- Types of Injury
- Common Deficits
- Regions of the Frontal Lobe and Their Functions

Definition of TBI

- A TBI is a traumatically induced structural injury and/or physiological disruption of brain function as a result of an external force that is indicated by new onset or worsening of at least one of the following clinical signs, immediately following the event: any period of a loss or decreased level of consciousness (LOC); any loss of memory for events immediately before or after the injury (post-traumatic amnesia [PTA]); any alteration in mental state at the time of the injury (confusion, disorientation, slowed thinking, etc.); neurological deficits (weakness, loss of balance, change in vision, praxis, paresis/plegia, sensory loss, aphasia, etc.) that may or may not be transient; or intracranial lesions.
- US Department of Veteran Affairs and the Department of Defense Clinical Practice Guidelines For Management of Concussion/mTBI (2009)

Mechanisms of Injury

- Closed head injury - trauma as a result of a blow to the head, or a sudden, violent motion that injures the brain by pushing the brain against the inside wall of the skull.
 - Closed head injuries tend to have more diffuse (widespread) effects on the brain.
- Open head injury – trauma as a result of an object penetrating the skull and the dura of the meninges.
 - Open Head injuries tend to have more localized (involving only the areas of the brain that were directly injured) effects on the brain.

Types of Injuries

- Primary Injuries = damage to the brain that occurs at the time of the TBI
 - Contusions = brain bruises
 - caused by brain tissue hitting against the inside of the skull
 - Hemorrhage/Hematoma = collection of blood
 - Identified by where the bleeding takes place (i.e., epidural, subdural, subarachnoid, intraparenchymal)
 - Axon Shearing = stretching and tearing of the axons of neurons.
 - Diffuse Axonal Injury or Shear Injury

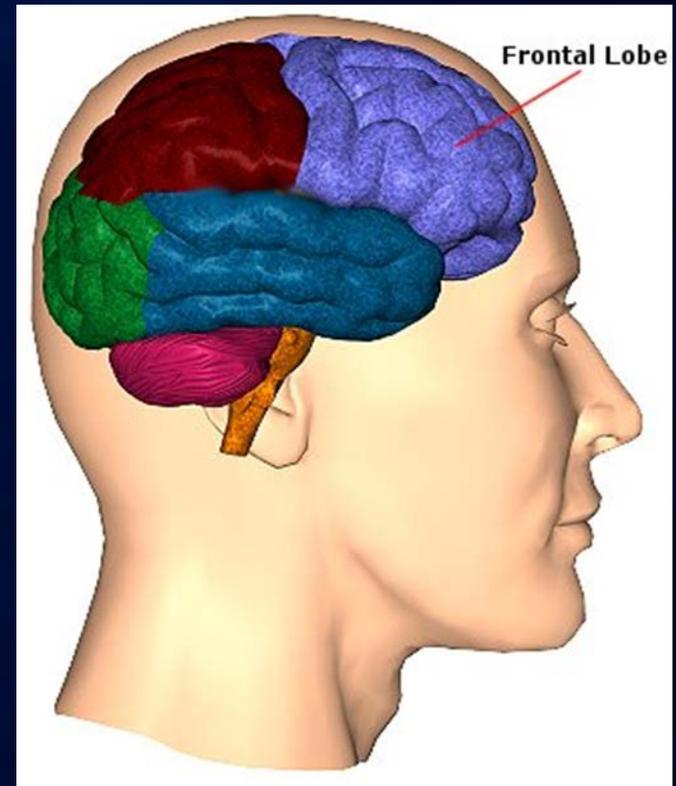
Common Deficits Associated with TBI

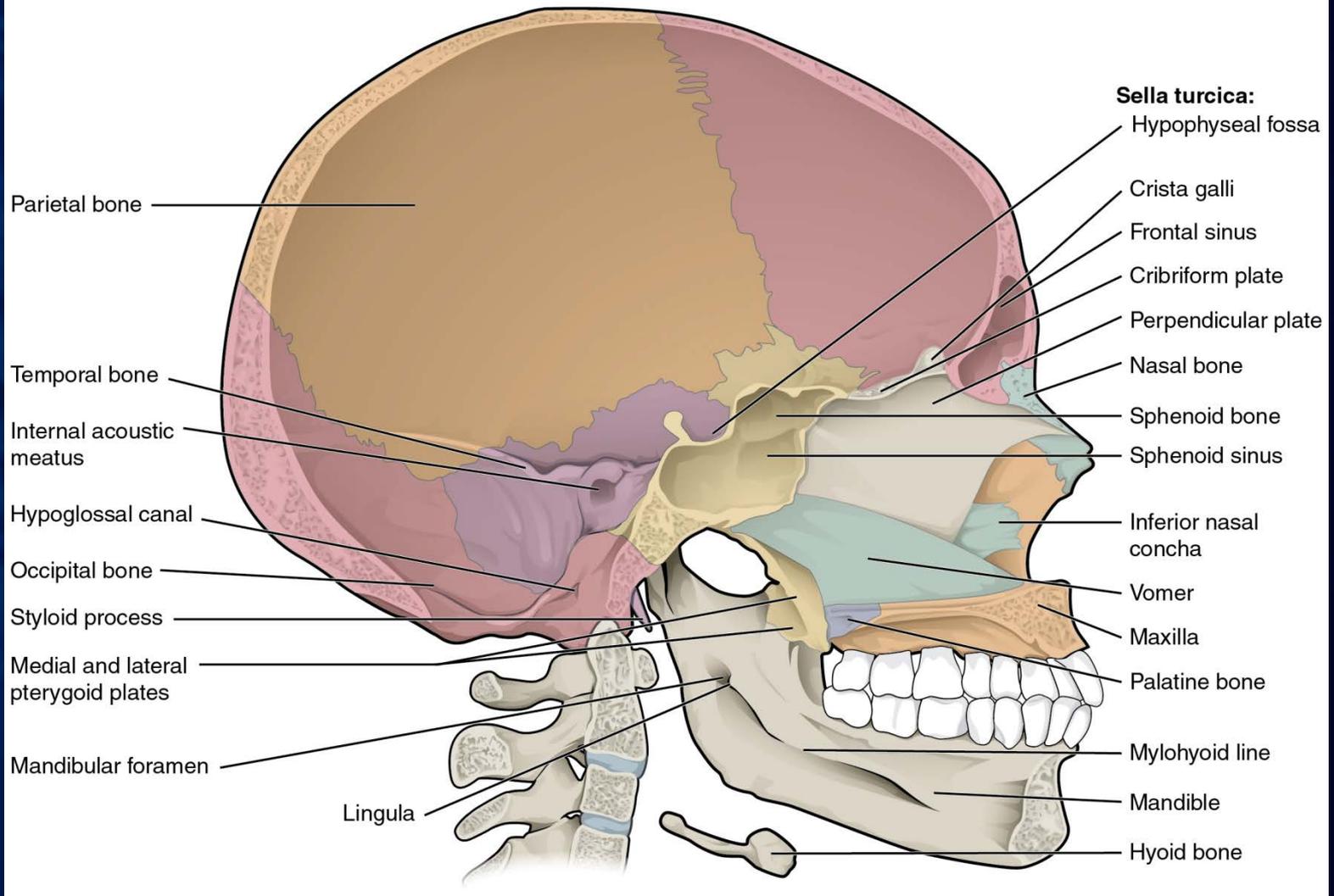
- Information Processing Speed*
 - Slow response time
- Attention*
 - Increased distractibility
 - Short attention span
 - Difficulty with divided attention
- Learning & Memory
 - For new information
- Executive functions

* Processing speed and attention are most commonly affected

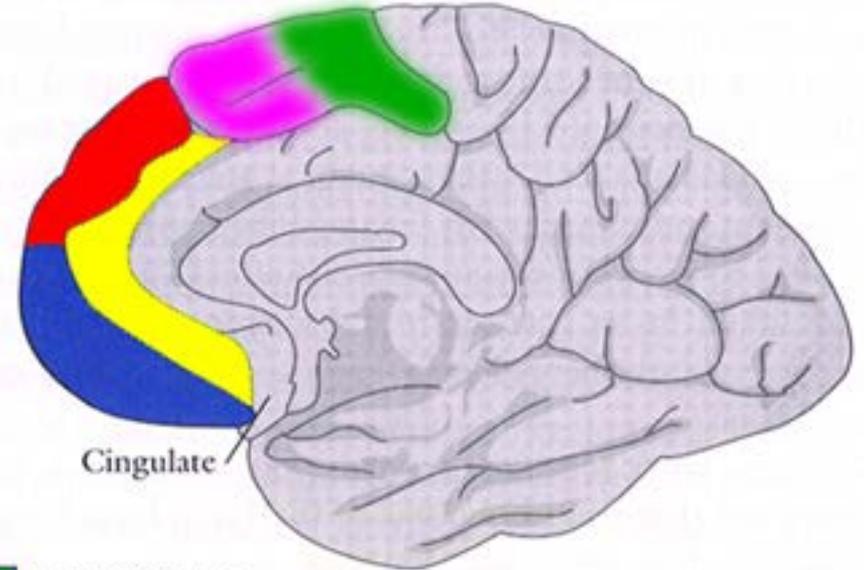
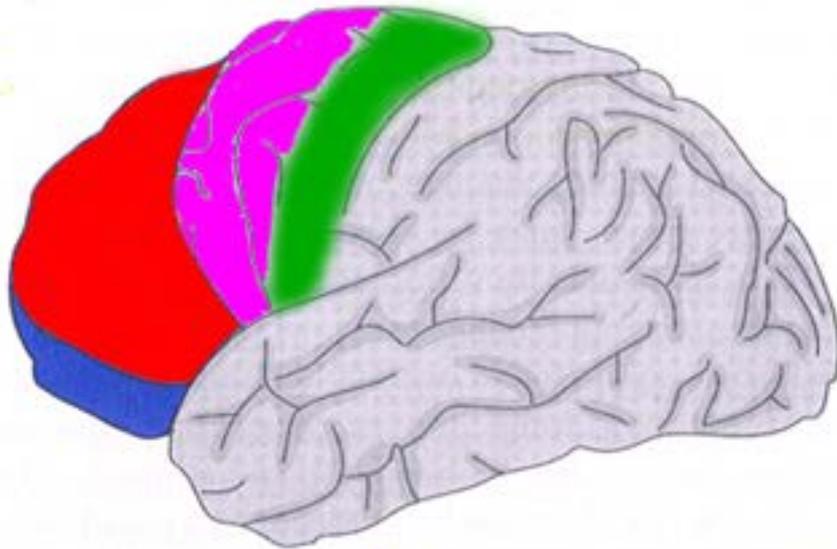
Frontal Lobes

- Most vulnerable to injury
 - Size – largest lobe
 - Location – bony projections in skull





Regions of the Frontal Lobe



- Dorsolateral area of Prefrontal
- Orbital area of Prefrontal
- Medial area of Prefrontal

- Motor Cortex
- Premotor Cortex

Regions of the Frontal Lobe

- Primary Motor Cortex
 - Located in the precentral gyrus, rostral to the central sulcus
 - Cortical neurons that project to the brainstem and spinal cord
 - Involved in the cortical control of voluntary movement
 - Damage results in:
 - Contralateral motor deficits
 - Initially a flaccid hemiparesis/hemiplegia
 - Later a spastic hemiparesis/hemiplegia

Regions of the Frontal Lobe

- Premotor Cortex
 - Located immediately rostral to the primary motor cortex
 - Assists in the integration of sensory and motor information for the performance of actions
 - Damage results in
 - Apraxia – inability to perform skilled actions that could previously be performed, but without paralysis
 - Deficits in contralateral fine motor control
 - Difficulty using sensory feedback for the control and performance of movements

Regions of the Frontal Lobe

- Frontal Eye Fields
 - Located rostral to the premotor cortex
 - Controls voluntary eye movement in the contralateral visual field for the purpose of active visual search
 - Damage results in:
 - Deficits in voluntary eye movements (active visual search), but preserved passive eye movement (the following of a moving object)

Regions of the Frontal Lobe

- Dorsolateral Prefrontal Cortex
 - Makes up the largest portion of the frontal lobe
 - Located rostral to the frontal eye fields and superior to the orbitofrontal cortex
 - Controls executive functions
 - Damage results in:
 - Perseveration
 - Task impersistence
 - Reduced sustained and complex attention
 - Reduced organizational skills
 - Reduced problem-solving, judgement, reasoning, insight

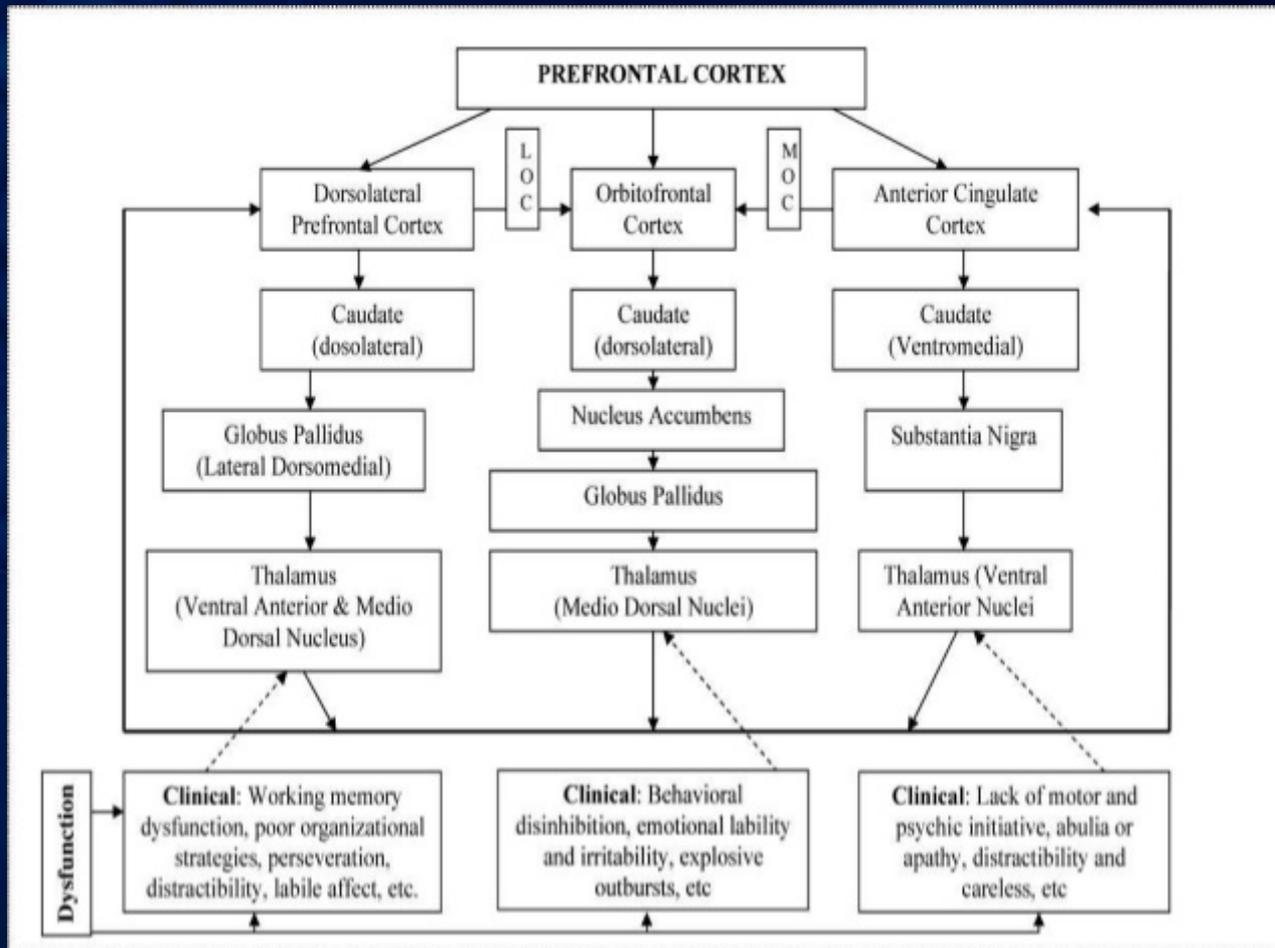
Regions of the Frontal Lobe

- Orbitofrontal Cortex
 - Inferior to the dorsolateral prefrontal cortex; most rostral portion of the frontal lobe
 - Controls the modulation of affective and social behavior, working memory, smell discrimination
 - Damage results in
 - Behavioral disinhibition
 - Socially inappropriate behaviors
 - Emotional lability
 - Irritability
 - Explosive outbursts

Regions of the Frontal Lobe

- Anterior Cingulate Cortex (Supplementary Motor Area)
 - Located in the medial portion of the frontal lobe superior to the corpus callosum
 - Connections to deep limbic structures
 - Control drive and motivation
 - Damage results in:
 - Reduced initiation
 - Apathy
 - Akinetic mutism
 - Complex attention deficits

The Frontal Circuits





Thank You