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# Brain Injury 102

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## **The Basics**

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# After completion of this module, the learner will be able to:

- Identify:
  - the basic types of brain injuries.
  - the types of insults to the brain's anatomy.
  - the potential effect(s) of the insult(s) to the anatomy of the brain.
  - the labeling systems used to classify the severity of brain injuries.
  
- Define “traumatic brain injury.”
  
- Explain:
  - how “severity” of brain injury is measured.
  - how “severity” and “impairment” do not measure the same impact.
  - typical sequelae based on where the insult(s) to the brain is(are).
  - impact of injury on an individual's life: Physical; Social; Emotional; Cognitive.

# Pre-Quiz – Part 1

True or False.

- F 1. All TBI are caused by an external blow to the skull.  
definition page 5
- T 2. Risk of a 2<sup>nd</sup> TBI is 3 times greater than the first.
- T 3. Stroke is a type of brain injury.
- T 4. Open head injury always involves a skull fracture.
- F 5. All secondary injuries to the brain involve bleeding.  
ANSWERS PAGE 11
- F 6. “Mild,” “moderate,” and “severe” refer to levels of impairment after brain injury. PAGE 17
- T 7. Effects of TBI can totally change a person’s personality.
- T 8. Some TBIs are localized to one area of the brain.
- T 9. CSF can cause complications, including death.
- F 10. The Rancho Los Amigos and Glasgow Coma Scale can predict levels of impairment. PAGE 14

Identify the type of brain Injury for which each statement is true: open head injury (O), closed head injury (C), or internal (I). May be more than one answer for each statement.

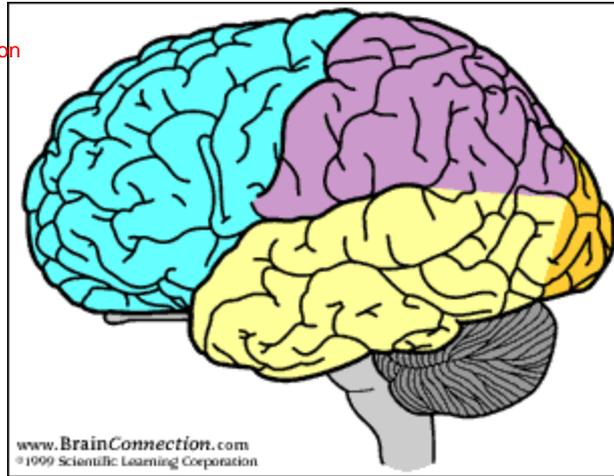
- I 1. caused by blood vessel burst.
- O,C 2. impact from outside source.
- O 3. skull fractured.
- I 4. brain deprived of oxygen.
- O 5. impairment localized.
- O 6. meninges and mater are compromised.
- C 7. coup-contrecoup actions cause damage.
- I 8. hemorrhaging may be involved.
- C 9. neurons and axons are sheared.
- C 10. biochemical cascade may occur.

# Pre-Quiz – Part 2

For each area, list 3 possible ways an brain injury may impact an individual.

## Frontal Lobe: PG28

1. Loss of spontaneity in response to others and the environ
2. Loss of flexibility in thinking
3. Perseveration
4. Attention deficits
5. Emotional lability
6. Changes in personality
7. Changes in social behavior
8. Difficulty in problem solving
9. Broca's aphasia
10. Disinhibition
11. Loss of self monitoring
12. Impaired working memory



## Parietal Lobe: page 26

1. Splitting attention
2. Anomia
3. Agraphia
4. Alexia
5. Dyscalculia
6. Difficulty drawing objects
7. Diff. distinguishing Left from Right
8. Inability to focus visual attention
9. Diff with eye/hand coordination
10. Apraxia that leads to difficulties in self care

## Temporal Lobe:

1. Prosopagnosia
2. Wernicke's aphasia
3. Disturbance with selective attention
4. Short term memory loss
5. Difficulty categorizing
6. Persistent talking
7. Auditory Deficits
8. Difficulty with concentration
9. Seizures
10. Change in sexual interest
11. Difficulty in location objects in the environment

## Brain Stem:

1. Decreased vital capacity in breathing
2. Difficulty with organization
3. Difficulty with perception of environment
4. Problems with balance
5. Problems with movement
6. Vertigo
7. Sleeping difficulties

## Cerebellum:

1. Loss of ability to coordinate fine movement
2. Loss of ability to walk
3. Inability to reach out and grab objects
4. Inability to make rapid movements
5. Tremors
6. Vertigo
7. Scanning speech

## Occipital Lobe:

Page 25

1. Visual field cuts
2. Loss of vision of opposite field
3. Color Agnosia
4. Diff locating objects in environment
5. Productions of hallucinations
6. Visual illusions, inaccurately seeing obj
7. Word blindness/ inability to recognize words
8. Movement agnosia
9. Difficulty reading
10. Difficulty writing
11. Difficulty recognizing drawn objects

# Traumatic Brain Injury

## Definition:

“Brain Injury is an insult to the brain, not of degenerative or congenital nature, the result of either an external physical force or internal cause, that produces an altered mental status, which results in an impairment of behavioral, cognitive, emotional, and/or physical functioning.”

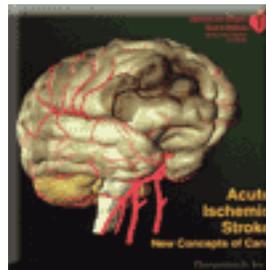
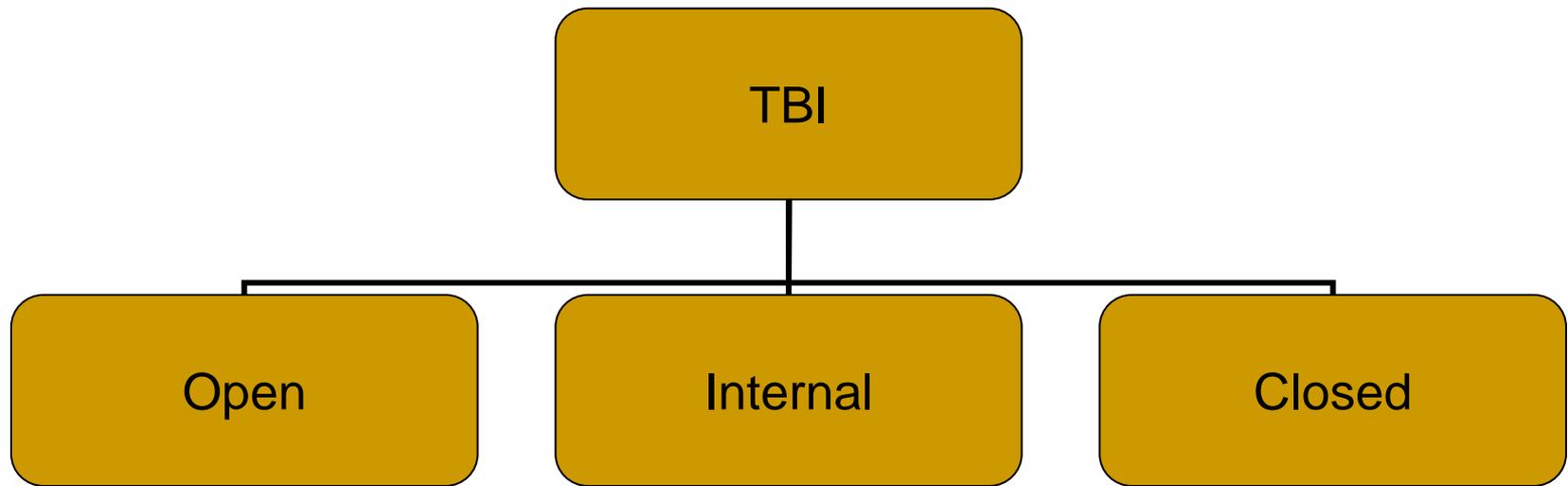
[Vermont Division of Vocational Rehabilitation, 1999]

## Statistically:

- A TBI occurs every 21 seconds.
- 1.4 million people sustain a TBI annually in the United States.
- 235,000 people hospitalized annually with TBI.
- After 1st TBI, risk for 2<sup>nd</sup> is 3 times greater.
- After 2<sup>nd</sup> TBI, risk for 3<sup>rd</sup> is 8 times greater.
- TBI injuries cost more than \$48.3 billion annually.

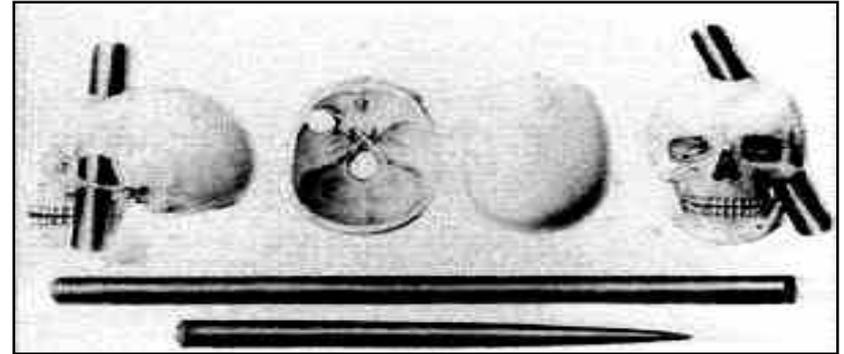
[Center for Disease Control, 2007]

# Types of Traumatic Brain Injuries



# Open Head Injury

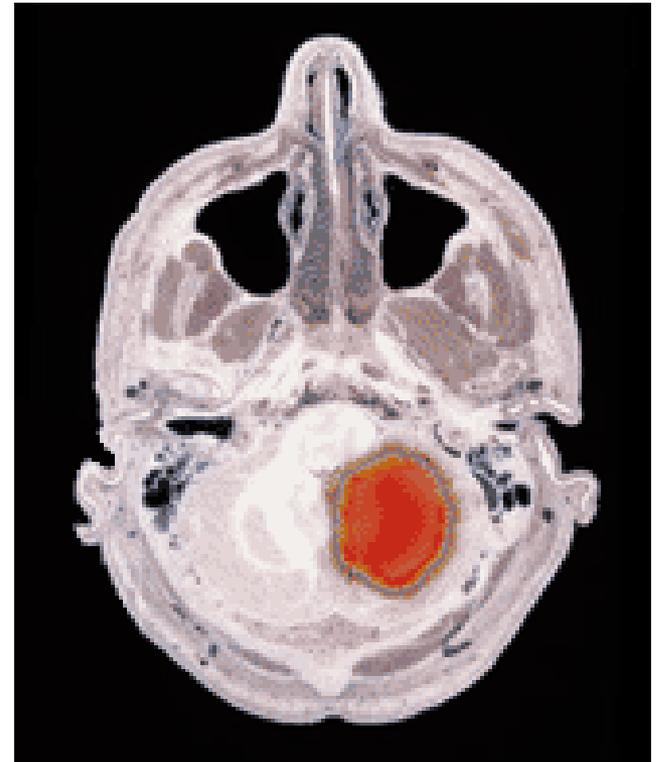
- Head receives an impact from an outside source.
- Skull is fractured or displaced.
- Meninges and mater are penetrated.
- May be bone fragments within brain tissue.
- Entire brain is at risk for more injury and/or infection.
- Impairment may be:
  - localized to area of brain penetrated.
  - Generalized due to ricochet effect of object within skull.



Phineas Gage, of Cavendish, Vermont, is the most celebrated example of an individual with an open head injury. In 1848, a steel tamping rod (13 lbs., 1.25" diameter) exploded through his skull and his left frontal cortex. He remained conscious until he saw the doctor who removed the iron. He developed a fungal infection and was semi-comatose for a couple of weeks. He physically recuperated and returned to work, but everyone found him to have become extraordinarily rude and profane. He died in 1860 following a series of seizures.

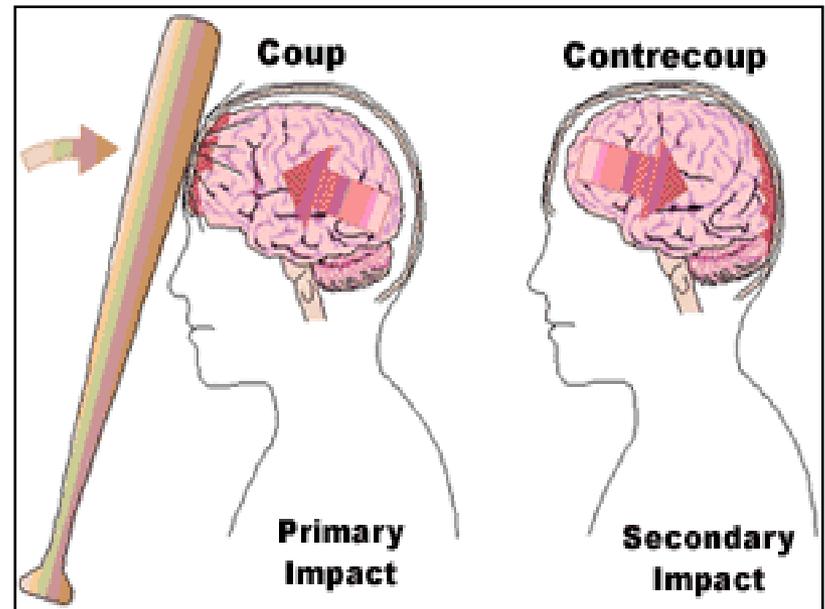
# Internal Brain Injury

- Stroke occurs when blood vessels:
  - Burst (hemorrhagic).
  - Clog (ischemic).
- Deprives brain area of:
  - Oxygen.
  - Blood.
- Neurons die from:
  - Lack of oxygen & blood.
  - Pressure from fluid.



# Closed Head Injury

- Also known as Coup-Contrecoup.
- Occurs when brain is accelerated, decelerated, or rotated rapidly.
- Usually the result of an impact from an outside source.
- Skull does not fracture or displace.
- Damage occurs because of violent movement which can lacerate, tear, shear, and contuse neurons and their connections.

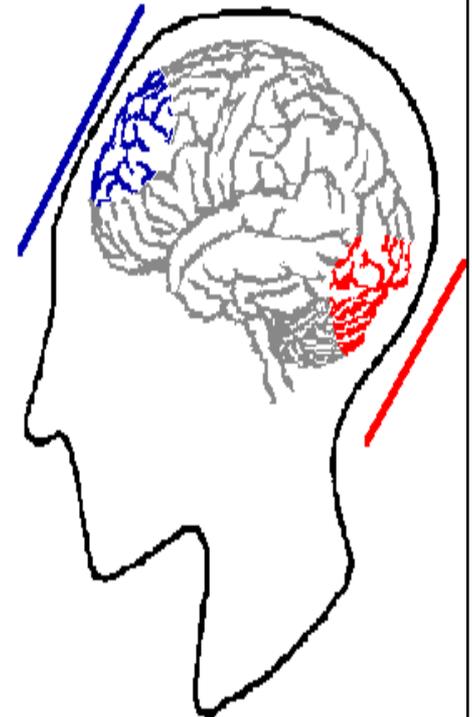


# Effects of Coup-Contrecoup

- Bruising at points of impact.
- Tearing and shearing of neurons.
- Destruction of axonal connections & myelin.
- Biochemical cascading.
- Leaking of CSF.
- Hemorrhaging.

The **coup** injury is caused when the head is stopped suddenly and the brain rushes forward. It not only gets injured by hitting in the side of the skull but is also damaged as it rubs against all the inner ridges.

The **contrecoup** injury is caused when the brain bounces off the primary surface and impacts against the opposing side of the skull. Again, additional injury occurs as the brain again rubs against all the inner ridges.



# Brain Injuries Secondary to Initial TBI

- **Edema** swelling of individual neurons due to influx of water following biochemical cascade in the brain.
- **Hydrocephalus** enlargement of the ventricles when cerebrospinal fluid (CSF) accumulates in the brain resulting in dilation of the ventricles and intracranial pressure (ICP).
- **Hemorrhaging** blood bleed from aneurysm or embolism of a blood vessel; can cause stroke; death of neurons; and/or increased intracranial pressure.
- **Anoxia** absence of oxygen to the brain; brain cells starve and die; may be caused by extensive bleeding elsewhere in the body, lack of breathing, or other gases replacing oxygen intake (e.g., carbon monoxide, helium).
- **Hypoxia** significant decrease in amount of oxygen getting to the brain; has same causes as anoxia; can trigger biochemical cascade.
- **Blood Clots** blockage elsewhere in body may travel to artery to the brain and cut off blood supply or hemorrhage; clotting within brain itself may cause stroke and hypoxia, triggering a biochemical cascade.
- **Biochemical Cascade** a series of chemical reactions within the brain as a result of all the cells firing at once; neurotransmitters are released which activate the receptors which spill out ions of calcium and potassium until the neurons become overwhelmed and go silent.
- **Seizures** abnormal electro-physiologic phenomena, resulting in abnormal synchronization of electrical neuronal activity; may manifest as an alteration in mental state, tonic or clonic movements, convulsions, and various other psychic symptoms.

# Second Impact Syndrome

- a.k.a. as “Recurrent TBI.”
- Occurs when a person sustains a second TBI before the symptoms of the first TBI have healed.
- Risk for second TBI is three times greater.
- Risk for third TBI is eight times greater.

“What happens with multiple head injuries is that in some instances, you lose thousands, if not more, nerve cells. Then you reach a critical limit where you start not to have enough nerve cells to function at the level that you once did. You now pick up permanent rather than transient neurologic impairment. That’s a supply-and-demand way of looking at it.”

[Dr. R.C. Cantu as quoted in *Head Games* (2007)]

# Scales to Measure Functioning

## Rancho Los Amigos Cognitive Scale - Revised

### ■ 10-point scale

- Level I      No Response: Total Assistance
- Level II     Generalized Response: Total Assistance
- Level III    Localized Response: Total Assistance
- Level IV    Confused/Agitated: Maximal Assistance
- Level V     Confused, Inappropriate Non-Agitated: Maximal Assistance
- Level VI    Confused, Appropriate: Moderate Assistance
- Level VII   Automatic, Appropriate: Minimal Assistance for Daily Living Skills
- Level VIII   Purposeful, Appropriate: Stand-By Assistance
- Level IX    Purposeful, Appropriate: Stand-By Assistance on Request
- Level X     Purposeful, Appropriate: Modified Independent

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# Scales to Measure Functioning

## Rancho Los Amigos Cognitive Scale - Revised

- Used to diagnose symptoms of TBI:
  - Awareness.
  - Cognition.
  - Behavior.
  - Interaction with environment.
- Short-hand communication within medical and rehabilitation field.
- Does **NOT** indicate severity of long-term impairments.

# Scales to Measure Functioning

## Glasgow Coma Scale

- 15-point scale:
  - i. Motor Response
    - 6 – Obeys commands fully
    - 5 – Localizes to noxious stimuli
    - 4 – Withdraws from noxious stimuli
    - 3 – Abnormal flexion, i.e. decorticate posturing
    - 2 – Extensor response, i.e. decerebrate posturing
    - 1 – No response
  - ii. Verbal Response
    - 5 – Alert and Oriented
    - 4 – Confused, yet coherent, speech
    - 3 – Inappropriate words & jumbled phrases consisting of words
    - 2 – Incomprehensible sounds
    - 1 – No Sounds
  - iii. Eye Opening
    - 4 – Spontaneous eye opening
    - 3 – Eyes open to speech
    - 2 – Eyes open to pain
    - 1 – No eye opening

# Scales to Measure Functioning

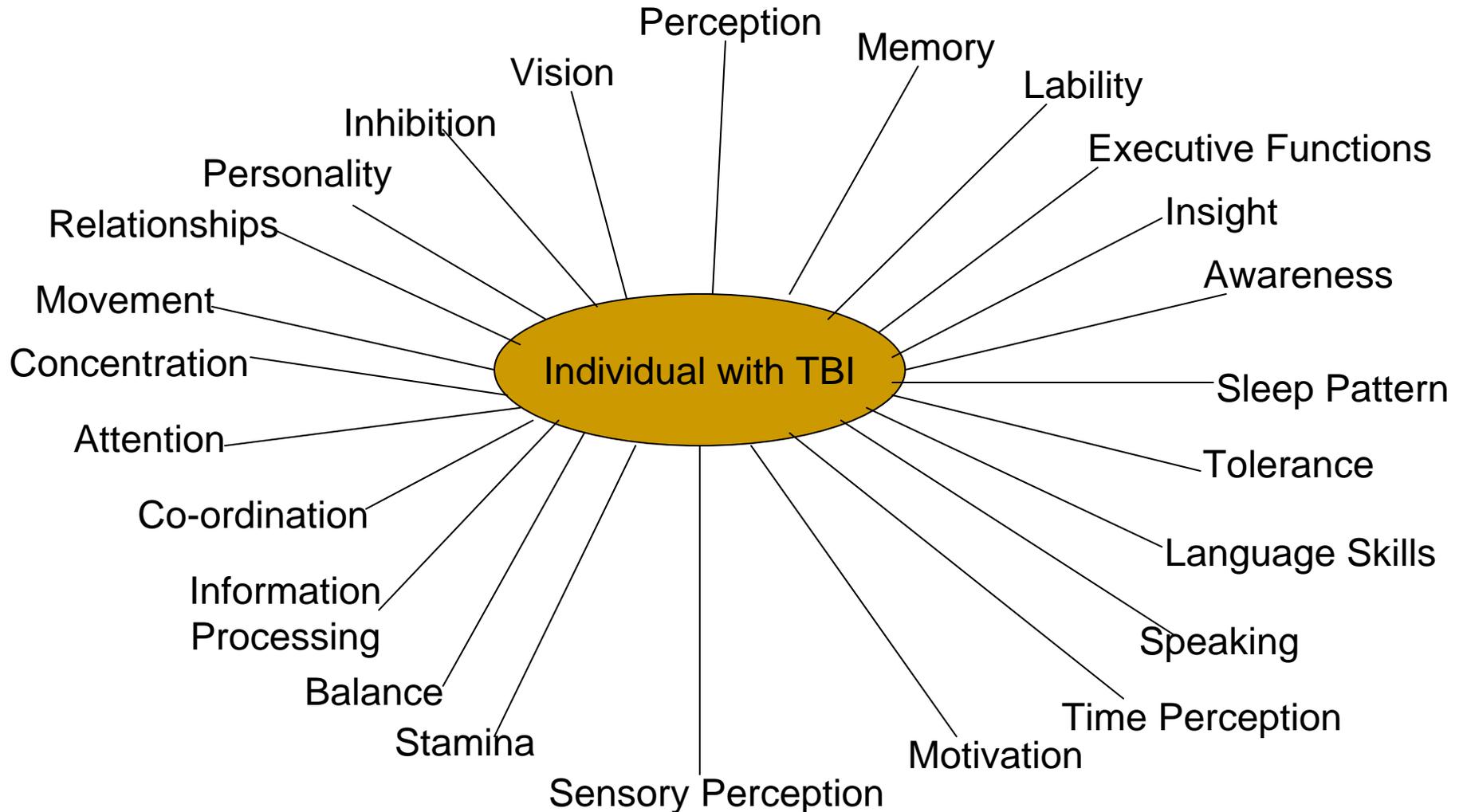
## Glasgow Coma Scale

- Used to estimate and categorize outcomes of TBI on basis of overall social capability or dependence on others.
- Final score determined by adding I + II + III.
- Number communicates to medical workers 4 possible levels for survival (15 = best; 0 = worst).
- Levels:
  - Mild (13 - 15)
  - Moderate Disability (9 – 12)
  - Severe Disability (3 – 8)
  - Vegetative State (Less than 3)
  - Persistent Vegetative State
  - Brain Death
- Based on the severity of the coma, this scale does **NOT** indicate severity or sequelae of long-term impairments.

# Impact of Brain Injury

- Labeling the level of brain injury (mild, moderate, severe) tends to be based on:
  - Length of loss of consciousness
  - Length of post-traumatic amnesia
  - Score on Glasgow Coma or Rancho Los Amigos scales
  - Number of residual symptoms at discharge
- Labeling does not involve:
  - Severity of long-term impairments
  - Physical, psycho-social, behavioral, or cognitive skills & deficits
  - Impact on daily living skills

# Impact of Brain Injury



# Impact of Brain Injury

## ■ Physical:

- Balance
- Movement
- Speech
- Vision
- Hearing
- Tactile
- Smell
- Taste
- Stamina
- Pain

## ■ Cognitive:

- Memory
- Attention/Concentration
- Processing Speed
- Quality of Thought Process
- Problem Solving
- Reading
- Writing
- Math

# Impact of Brain Injury

## ■ Executive Functions:

- Goal Setting
- Problem Solving
- Reasoning
- Learning from Feedback
- Inhibition
- Self-Control
- Organizing
- Delaying gratification
- Initiation

## ■ Social:

- Poor Judgment
- Empathy
- Theory of Mind
- Language Pragmatics
- Friendship Maintenance
- Isolation
- Impulsivity
- Conversation Maintenance

# Impact of Brain Injury

## ■ Personality:

- Aggression
- Passivity
- Lability
- Irritability
- Disinhibition
- Amotivation
- Indifference

## ■ Psychiatric:

- Depression
- Mania
- Anxiety
- Psychosis
- Substance Abuse
- Rage
- Anger

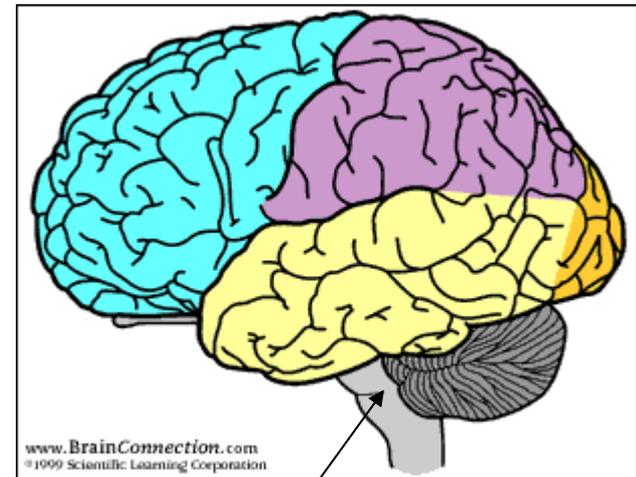
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# Impact of Brain Injury

- **The most important things to remember:**
  - A person with a brain injury is a person who deserves dignity and respect.
  - No two brain injuries are exactly the same.
  - The effects of brain injury are complex and vary greatly from person to person.
  - While plateaus happen, recover from brain injury can improve for years after the injury – deficits can be rehabilitated.
  - The effects of a brain injury depend on such factors as severity, cause, and location within the brain.

# Brain Stem – Possible Impairments

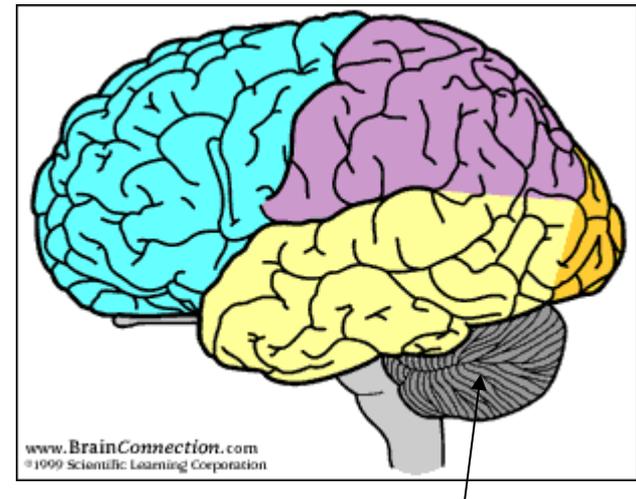
- Problems:
  - Decreased vital capacity in breathing.
  - Difficulty with organization.
  - Difficulty with perception of environment.
  - Problems with balance.
  - Problems with movement.
  - Vertigo.
  - Sleeping difficulties.



Brain Stem

# Cerebellum – Possible Impairments

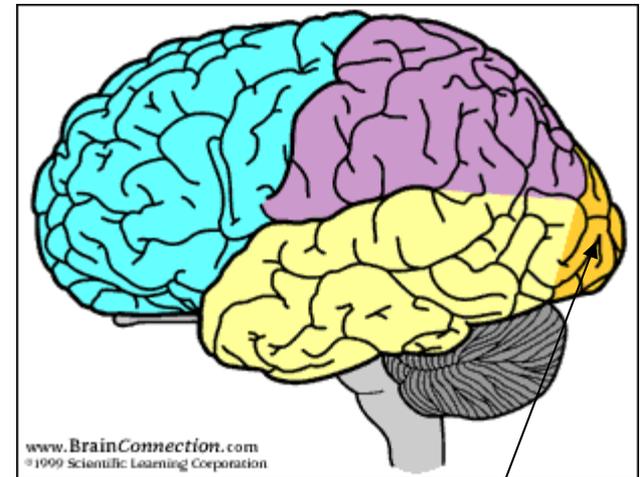
- Problems:
  - Loss of ability to coordinate fine movements.
  - Loss of ability to walk.
  - Inability to reach out and grab objects.
  - Inability to make rapid movements.
  - Tremors.
  - Vertigo.
  - Scanning speech.



Cerebellum

# Occipital Lobes – Possible Impairments

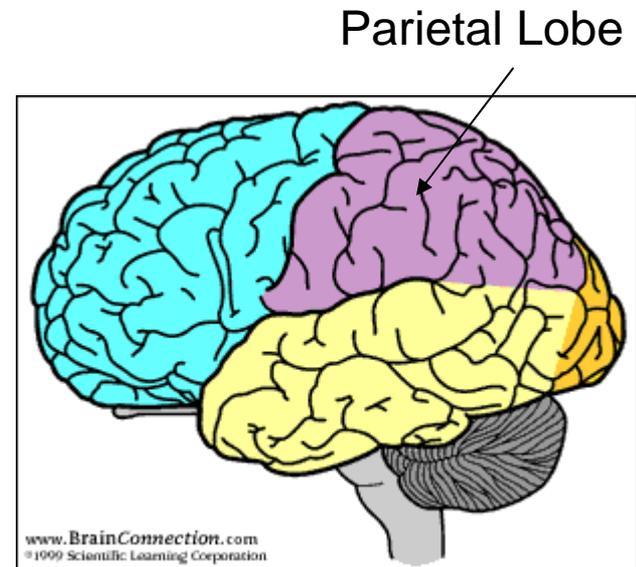
- Problems:
  - Visual field cuts.
  - Loss of vision of opposite field.
  - Color agnosia.
  - Difficulty locating objects in the environment.
  - Productions of hallucinations.
  - Visual illusions – inaccurately seeing objects.
  - Word blindness – inability to recognize words.
  - Movement agnosia.
  - Difficulty in reading.
  - Difficulty in writing.
  - Difficulty recognizing drawn objects.



Occipital Lobe

# Parietal Lobes – Possible Impairments

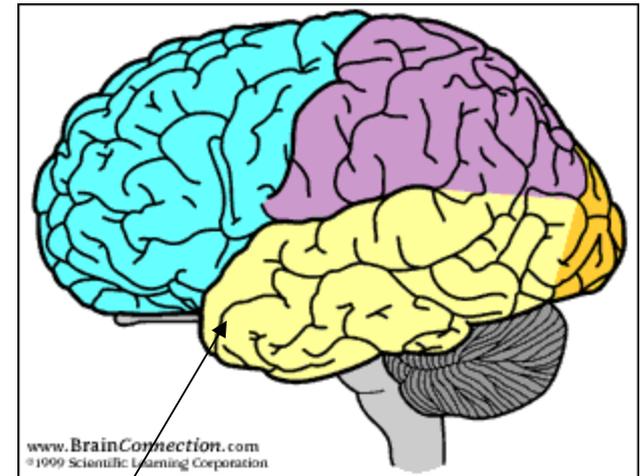
- Problems:
  - Splitting attention.
  - Anomia.
  - Agraphia.
  - Alexia.
  - Dyscalculia.
  - Difficulty drawing objects.
  - Difficulty distinguishing left from right.
  - Apraxia that leads to difficulties in self-care.
  - Inability to focus visual attention.
  - Difficulties with eye-hand coordinaton.



# Temporal Lobes – Possible Impairments

## ■ Problems:

- Prosopagnosia.
- Wernicke's aphasia.
- Disturbance with selective attention.
- Short-term memory loss.
- Difficulty categorizing.
- Persistent talking.
- Auditory Deficits.
- Difficulty with concentration.
- Seizures.
- Change in sexual interest.
- Difficulty in locating objects in the environment.

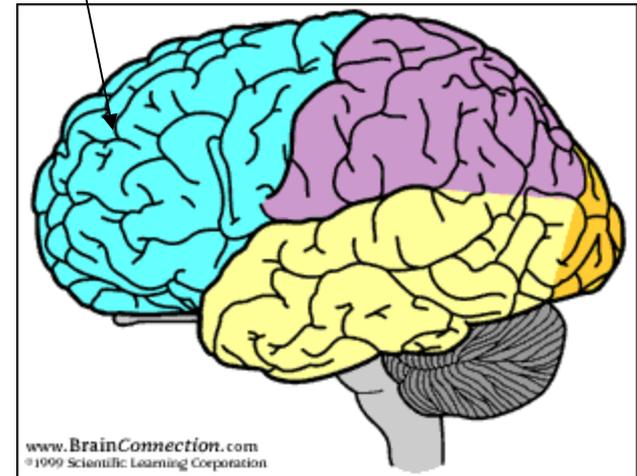


Temporal Lobe

# Frontal Lobes – Possible Impairments

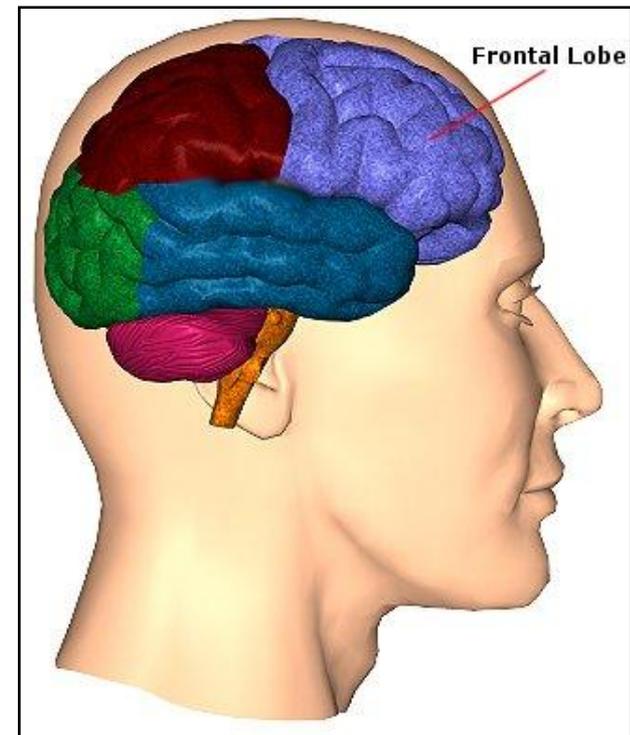
- Problems:
  - Loss of spontaneity in response to others and the environment.
  - Loss of flexibility in thinking.
  - Perseveration.
  - Attention deficits .
  - Emotional lability.
  - Changes in personality.
  - Changes in social behavior.
  - Difficulty in problem solving.
  - Broca's aphasia.
  - Disinhibition.
  - Loss of metacognitive skills.
  - Loss of self-monitoring.
  - Impaired working memory.

Frontal Lobe



# Prefrontal Lobes – Uniqueness

- Largest group of individuals sustaining TBI are between the ages of 0 to 4 and 15 to 19.
- Most vulnerable part of brain in accidents – due to location and boney protrusions inside front of skull.
- The prefrontal lobes don't fully develop until age 25.
- Almost nothing is done by the brain without prefrontal lobe involvement.



# Prefrontal Lobes – Executive Functions

Everyone's Executive Functions fall along a continuum of development.

**Mature.....Impaired**

Inhibition

Disinhibition

Attention

Inattention

Time Perception

No Concept of Time

Self-Regulation

No Delaying Gratification

Initiation

No Self-Starting

Ability to Judge

Poor Judgment

Goal-Setting

Living in the Moment

# Post-Quiz – Part 1

True or False.

- F** 1. All TBI are caused by an external blow to the skull.
- T** 2. Risk of a 2<sup>nd</sup> TBI is 3 times greater than the first.
- T** 3. Stroke is a type of brain injury.
- T** 4. Open head injury always involves a skull fracture.
- F** 5. All secondary injuries to the brain involve bleeding. PAGE 11
- F** 6. “Mild,” “moderate,” and “severe” refer to levels of impairment after brain injury. PAGE 17
- T** 7. Effects of TBI can totally change a person’s personality.
- T** 8. Some TBIs are localized to one area of the brain.
- T** 9. CSF can cause complications, including death.
- F** 10. The Rancho Los Amigos and Glasgow Coma Scale can predict levels of impairment.

Identify the type of brain Injury for which each statement is true: open head injury (O), closed head injury (C), or internal (I). May be more than one answer for each statement.

- I** 1. caused by blood vessel burst.
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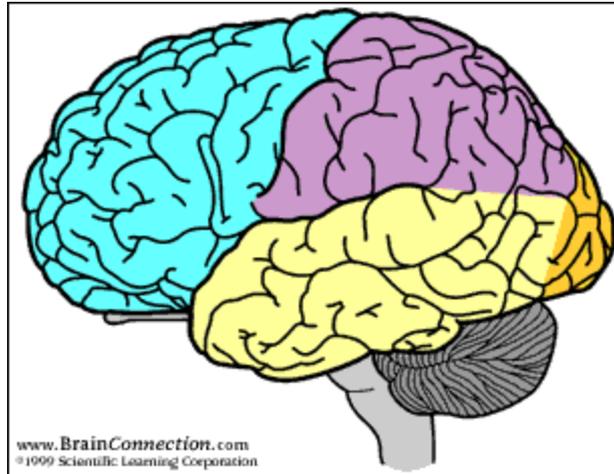
# Post-Quiz – Part 2

For each area, list 3 possible ways an brain injury may impact an individual.

## Frontal Lobe:

PG28

Loss of spontaneity in response to others and the environment  
Loss of flexibility in thinking  
Perseveration  
Attention deficits  
Emotional lability  
Changes in personality  
Changes in social behavior  
Difficulty in problem solving  
Broca's aphasia  
Disinhibition  
Loss of self monitoring  
Impaired working memory



## Parietal Lobe:

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Seizures  
Change in sexual interest  
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## Brain Stem:

Decreased vital capacity in breathing  
Difficulty with organization  
Difficulty with perception of environment  
Problems with balance  
Problems with movement  
Vertigo  
Sleeping difficulties

## Cerebellum

Loss of ability to coordinate fine movement  
Loss of ability to walk  
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## Occipital Lobe:

Visual field cuts  
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Productions of hallucinations  
Visual illusions, inaccurately seeing obj  
Word blindness/ inability to recognize words  
Movement agnosia  
Difficulty reading  
Difficulty writing  
Difficulty recognizing drawn objects

# Post-Quiz – Part 3

Answer each of the following questions:

1. Define traumatic brain injury per the State of Vermont. “Brain Injury is an insult to the brain, not of degenerative or congenital nature, the result of either an external physical force or internal cause, that produces an altered mental status, which results in an impairment of behavioral, cognitive, emotional, and/or physical functioning.” page 5
2. What do the labels “mild,” “moderate,” and “severe” indicate about a TBI? Tends to be based on length of LOC and posttraumatic amnesia, glasgow coma scale or Rancho Los Amigos scales, number of residual symptoms at discharge page 17
1. Why is injury to the pre-frontal lobes so significant? It is the most vulnerable part of the brain due to location and boney protrusions inside front front of skull. The prefrontal lobes don’t fully develop until 25. ALMOST nothing is done by brain without prefrontal lobe involvement. It is the Executive functions. Page 29
1. Explain why an individual with significant impairment in all areas (cognitive, physical, social-emotional, etc.) may be labeled with a “mild” TBI. The labels do not involve Severity of the impairments, the physical, psychosocial, behavioral, or cognitive skills & deficits or the Impact on daily living skills. Page 17
2. Explain the impact of TBI on an individual:
  - Physically:: balance, movement, speech, vision, hearing, tactile, smell, taste, stamina, pain
  - Socially: poor judgement, empathy, theory of mind, language pragmatics, friendship maintenance, isolation, impulsivity, conversation maintenance
  - Cognitively: memory, attention/concentration, processing speed, quality of thought process, problem solving, reading, writing, math
  - Emotionally: Goal setting, problem solving, reasoning, learning from feedback, inhibition, self-control, organizing, delaying gratification, initiation

# Learning Outcomes Checklist

Can you:

Identify:

- the basic types of brain injuries.
- the types of insults to the brain's anatomy.
- the potential effect(s) of the insult(s) to the anatomy of the brain.
- the labeling systems used to classify the severity of brain injuries.

Define “traumatic brain injury.”

Explain:

- how “severity” of brain injury is measured.
- how “severity” and “impairment” do not measure the same impact.
- typical sequelae based on where the insult(s) to the brain is(are).
- impact of injury on an individual's life: Physical; Social; Emotional; Cognitive.