Overview of Traumatic Brain Injury, Assessment Considerations, and Recommendations for Support

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Overview

- Developmental and plasticity context for TBI
- Basics of TBI
- Neurocognitive impacts of TBI
- Impacts on daily functioning
- Assessment considerations linked to these factors
- Resources and supports

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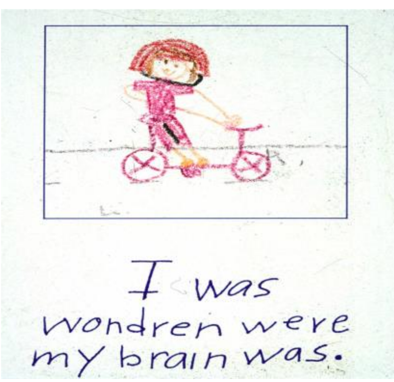

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Overview of Neural Development

- The progression of myelination occurs in the following sequence:
  - Overview of Early Brain Development
  - Vestibular and spinal tracts, cerebellum, internal capsule, thalamus, and basal ganglia-prenatal
  - Midbrain cortical visual pathways-2-3 months.
  - Descending lateral corticospinal tracts-12 months
  - Cerebellar-cerebral connections-between 1 and 2.
  - Hippocampal, limbic, and reticular activating tracts-well into school age
  - Connections between primary and associative cortices continue-during late childhood and into adolescence
  - Frontal lobes-complete around 25 years

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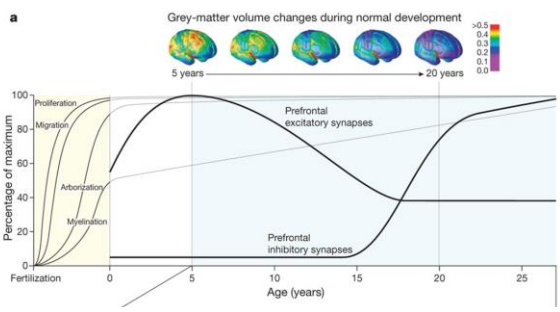

Why are we talking about early brain development in a TBI presentation? If injury happens during these developmental processes, that developmental window is disrupted, as are all windows after that. Brains function from the foundation up.

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Plasticity Considerations

Research regarding lesion type and outcome suggests the following:

- Those who sustain small focal lesions are more likely to have more positive outcomes (in comparison with larger ones).
- Large, unilateral lesions have been associated with similar findings when compared to that seen in small focal lesions. This is attributed to interhemispheric transfer of function (from one to another).
- For moderate or bilateral lesions, research notes little functional plasticity and far worse outcomes.

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Plasticity Considerations

- Global or generalized damage (severe bilateral head trauma, anoxia) suggests poor outcomes as well.
- There appears to be a dose-response relationship in these cases.

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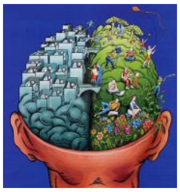
Plasticity Considerations

- We are generally taught that the left side manages language and the right side visual/spatial. This is an overly simplistic view. Coordinated communication between the hemispheres is required for complete language and visual-spatial/perceptual processing.
- Although it is clear that lateralization exists, one cannot overlook the parallel processing that occurs for most neurocognitive functions.
- Consider that language without the right hemisphere would be like reading emails with no ☺ or ;) or ☹.



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Plasticity Considerations

- The right hemisphere is comprised of more association cortex, which makes it better at intermodal integration.
- There are three stages of neuronal development that occur in association with the emergence of new skills:
  1. first right hemi growth,
  2. left hemi growth and
  3. parallel growth between the two
- This occurs in roughly this sequence again and again as the brain grows and develops

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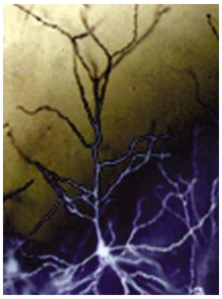
Plasticity Considerations

When growth occurs in the right hemisphere it causes contraction in the connectivity, moving from distant connections to close ones (increased sophistication of localized growth; diversification of small portions, increased dendritic branching).

This is essentially the process of honing and refining processes



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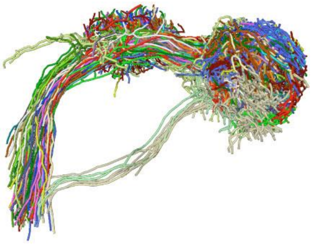
Plasticity Considerations

When growth occurs in the left hemisphere, connectivity expands, moving from close to more distant connections (more integrated by facilitating growth into more distant region; extension of axonal projections).

This means better integration and communication



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Plasticity Considerations

- Evolutionarily, it is thought that the development of oral and written language necessitated the rapid growth of the left hemisphere, which shoved the other, older functions into the right hemisphere.
- Interestingly, when there is damage associated with early development, the left (newer?) hemisphere appears to be more resilient. This is true for problems such as prematurity, where it is more likely for there to be ongoing right hemi deficits (motor, attention).

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Plasticity Considerations

- During early development, it has been hypothesized the dominant hemisphere becomes more and more specialized for language.
- Research has suggested that if very early insults to the language dominant hemisphere occur, there are milder deficits in children (in comparison with adults) and indications that altered dominance has been established (recruitment of the other side).
- This effect is thought to only be true in very young children (under 5); research is somewhat mixed.

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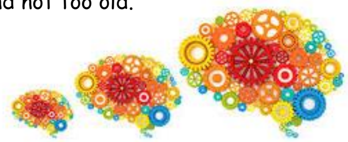
Plasticity Considerations

- Functional imaging studies after early insult have indicated that the functional plasticity seen in children (in comparison with adults) can be attributed more to recruitment than true reorganization (whole process is not shifted over to the other side).
- Additionally, findings support that lesions in the left hemisphere are more amenable to the recruitment process when the person is not too young and not too old.



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Plasticity Considerations

- Research has suggested that children with lesions sustained under the age of 1 in the left or right hemispheres (unilaterally) show global depression across both domains, with the right being more sensitive to specific deficits.
- In children more than one year old, there appears to be generally intact verbal and performance IQ scores with left hemisphere lesions, but selective right hemisphere insults result in right side deficits.
- Adults typically present with unilateral damage to the affected side with generally intact function in the undamaged hemisphere (lack of plasticity).

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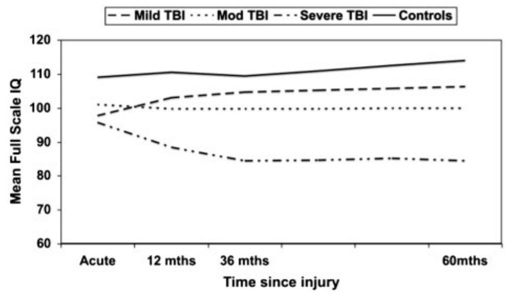
Plasticity Considerations

- Recovery trajectories for intellectual ability over 5 years following childhood traumatic brain injury (TBI) (adapted from Anderson et al., 2009a).



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Plasticity Considerations

- Plasticity mechanisms present when cerebral damage occurs appear to be mediated by <u>age at onset</u> and <u>lesion type</u>.
- Interhemispheric transfer (recruitment of analogous regions, delegation of demand) occurs more often between birth and age 2 and when there is a devastating injury to most of one hemisphere
- When interhemispheric transfer occurs, it is argued that language and some non-language functions (memory) may transfer to the analogous site in the other hemisphere.
- This may not be greatly advantageous due to be a <u>crowding</u> effect, which causes decreases in undamaged functions that are consistent with more global deficits like those seen in adults (ex: brain on maternity leave)

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Plasticity Considerations

- Intrahemispheric maintenance refers to the <u>absence</u> of transfer
- Skills subsumed by damaged tissue are maintained within that tissue, resulting in maximal dysfunction.
- Occurs in situations when damage is very widespread and reduced local or contralateral options for repair exist, across all ages
- The age range for this type of plasticity is thought to also occur in 2-8 year olds with some focal injuries

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Plasticity Considerations

Compensatory processes

- Many factors affect severity and outcome of injury
  - the worst time for cerebral insult is in the 3rd trimester.
  - best is 8-12 months of age?
  - Beyond birth injuries, it is suggested that 7-9 years old may be the worst childhood period-this is a time when whole brain myelination peaks and the brain is very vulnerable
  - different mechanisms=different microscopic changes-limits the type and amount of regeneration and sprouting possible.
  - each person has individual potential for latent pathways and reversal of inhibitory mechanisms (cognitive reserve)-can't predict this

Plasticity Considerations

- the most likely compensatory mechanism to be observed is the process of redundant structures performing compensatory execution of tasks, although at a less efficient level.

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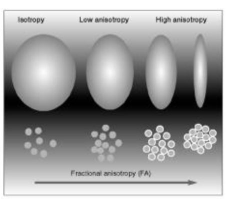
DTI Results

- Ewing-Cobbs, et al. (2016)-Diffusion tensor imaging study kids/adolescents 6-15 yo compared with ortho controls; measured at 3 and 24 mo post TBI
- Results drawn from fractional anisotropy (FA)

FA thought to reflect fiber density, axonal diameter, and myelination in white matter



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DTI Results

- Results suggested lower FA bilaterally in all 7 association pathways studied in TBI group
- In children, left hemi association pathways showed lowest initial integrity but greatest increase in FA over time=continued development despite incomplete recovery
- Adolescents had limited FA over time and the greatest residual deficits (arrested development)
- Neurodegenerative changes in both age groups attributed to elevated radial diffusivity (demyelination)
- Thus, results by age group suggest child FA was significantly lower in comparison with adolescents (initially worse), who showed fewer initial impacts but limited positive change over time

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DTI Results

- Primary damage to the prefrontal lobes appears to cause disruption in several association pathways (below)
- All of these peak in development in the adolescent period
  - Superior longitudinal fasciculus-dorsal association pathway with long and short fibers that connect perisylvian portions to frontal, temporal, and parietal lobes
  - Inferior longitudinal fasciculus-ventral pathway with long and short fibers connecting the occipital and temporal lobes; also connects with limbic regions, amygdala, and hippocampus via projections to the temporal lobes
  - Inferior fronto-occipital fasciculus-ventral pathway connecting orbitofrontal regions to the occipital lobes
- Continues to develop after adolescents and into adulthood
  - Uncinate fasciculus-ventral pathway that connects anterior temporal with medial and lateral orbitofrontal cortex

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DTI Results

- Ewing-Cobbs et al., 2016 take home
- Children show greater initial reductions in functioning/communication
- Adolescents don't recover as well because there is little opportunity for "catch up" growth"
- This limits microstructure recovery and/or reorganization
- The pathways that connect cortical to subcortical areas and the corticospinal tracts mature relatively early in late childhood
- Despite wide peak development window between 8.5 and 13.5 years, these were not preferentially disrupted in TBI groups
- Chronic elevation in radial diffusivity suggests demyelination that persists at 2 years post TBI; supports assertions that the TBI recovery window may be as long as 5 years and that deficits often continue to emerge over time

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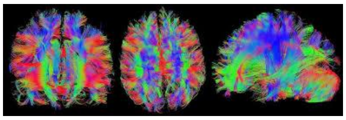
DTI Results

- Ewing-Cobbs et al., 2016 take home
- Standard deviation trajectories suggest a rapid increase in connectivity with age in the LT hemi and decreases in adolescence in the RT hemi (in normal controls)
- Microstructure damage evolves over time and interacts with ongoing developmental changes=this makes it hard to isolate difference between typical development, repair processes, and plasticity/reorganization
- Results suggest that regardless of location of injury (uni RT, uni LT, or bilat), effects are more pronounced in LT pathways



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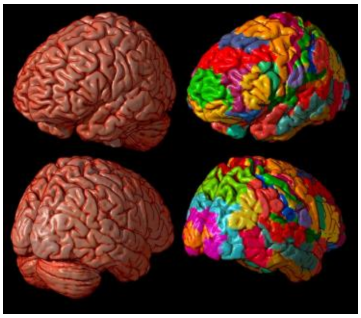
Now, back to TBI!



Myths About Brain Injury

MYTH

Visible, physical recovery is a sign that the brain has healed.

REALITY

The cognitive and behavioral effects of a brain injury can last long after the person heals "on the outside."

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Myths About Brain Injury

MYTH

Younger children are more resilient and can therefore “bounce back” easier and more quickly from a brain injury.

REALITY

It may just take longer for the effects of a brain injury to show up in a growing and developing brain.

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Myths About Brain Injury

MYTH

Mild brain injury has no long term effects.

REALITY

Even a 60 second loss of consciousness has been shown to result in DAI (as seen on autopsy).

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Myths About Brain Injury

MYTH

Time heals.

REALITY

There is no cure for a brain injury.

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Types of Brain Injury

- Brain Injury
  - Congenital and Perinatal (no period of normal development)
    - Perinatal (e.g., birth stroke)
    - Congenital (e.g., PKU)
  - Acquired (following a period of normal development)
    - Non-traumatic (internal occurrence e.g., tumor)
    - Traumatic (external physical force)
      - Open (e.g., gunshot)
      - Closed (e.g., fall)

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Not TBI

- Injuries associated with no premorbid period of normal development (during gestation)
- Injuries of this type do not fall under the TBI handicapping code
- Other non-TBI diagnoses
  - Seizure disorders
  - Genetic disorders involving the brain
  - Anoxia
  - Stroke/AVM

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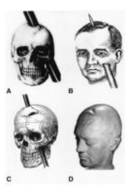
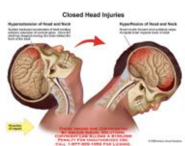
Types of Traumatic Brain Injury

- Open Head/Brain Injury: Brain injury in which the skull, meninges, and brain are penetrated by an external object (e.g., gunshot, metal rod).
- Closed Head/Brain Injury: Brain injury in which the skull and meninges are NOT penetrated (e.g., head hits the dashboard/windshield, object strikes head).





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Incidence and Prevalence of TBI

- Those most likely to sustain a TBI are those in the 0-4, 15-19, and over 65 age groups.
- TBI rates are almost universally higher in males versus females. Why?
- Males in the 0 to 4 age range have the highest rates of TBI-related ER visits, hospitalizations, and death.

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Incidence and Prevalence of TBI

- Falls continue to be the leading cause of TBI in the USA and are responsible for half of all pediatric (0-14) TBIs.
- TBI associated with a motor vehicle traffic accidents is the second leading cause (across ages) but results in the highest percentage of TBI-related deaths.
- Being struck by or coming into contact with another object accounts for approximately 35% of pediatric TBIs.
- 18% of all TBI-related ER visits involved children 0-14 (CDC, 2010).

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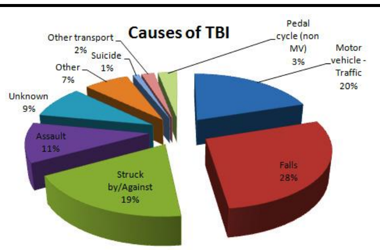

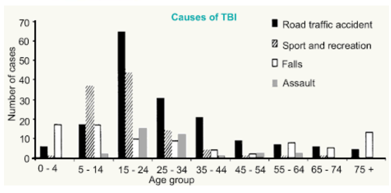

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Causes of TBI by Age

- Newborns (not included in most states as being TBI, usually OHI)
  - Delivery head injury-Caused by head compression and traction through the birth canal (vaginal delivery) with obstetric instruments.
  - Intracranial hemorrhages-low birth weight and hypoxemia are risk factors for intracranial hemorrhage

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Causes of TBI by Age

- Infants
  - Accidental head injury-Caused by inappropriate childcare practices.
  - Abusive Head Trauma-inflicted injuries, shaken baby syndrome
- Toddlers and School children
  - Accidental head injury-Caused by accidents increase as children develop motor ability.
  - Pedestrian injury also increases in this age group.

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Causes of TBI by Age

- School age
  - Increased MVA and outdoor injuries (more independent, more options for mobility)
  - Emergent sports injuries
- Adolescents
  - MVA
  - Bicycle and motorcycle-related accidents
  - Sports-related head injuries
- Trainers and players those involved in contact sports (i.e., soccer, hockey, football, martial arts) will require education about concussion (Araki, Yokoto, and Mortia, 2017).

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Risk Factors for Sustaining TBI

- Behavior problems
- Difficult infant/childhood temperament
- Dysfunction in family
- Depressed mother
- Premorbid impulsivity and hyperactivity/ADHD
- Placement in EBD classrooms
- Previous TBI

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Typical Medical Course for a Student with a Moderate/Severe TBI

- Emergency room
- Regional trauma center if necessary
- Surgery if necessary
- Acute care setting (hospital)
- Rehabilitation unit or center
- Hospital/Homebound School?
- School

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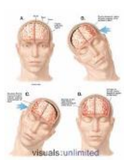
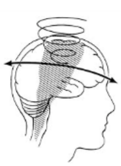
Primary Effects of Closed Head/Brain Injury

- Injury to brain tissue at the site of coup (first injury) and contra coup (second injury)
  - Localized/focal injuries
- Shearing and tearing of neurons throughout the brain
  - Diffuse axonal injuries (DAI)





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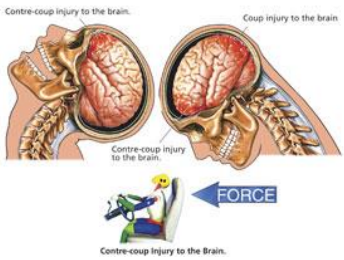
Closed Head Injury



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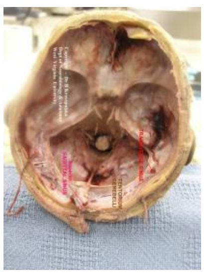
Closed Head Injury



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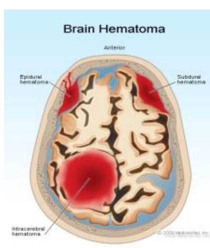
Secondary Effects of Closed Head/Brain Injury

- Big Picture
- Bleeding (leads to increased intracranial pressure).
- Swelling (leads to increased intracranial pressure).
- Lack of oxygen available to the brain because of blood (causes both focal and widespread cell death).



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Secondary Effects of Closed Head/Brain Injury

- Microscopic impacts
- Beyond structural damage, there are also neurometabolic changes
- Players=
  - N-acetylaspartate (NAA)-marker for neuronal and axonal integrity
  - Choline-indicates the presence of cell loss and cell membrane turnover when reduced and cell proliferation and gliosis when increased

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Secondary Effects of Closed Head/Brain Injury

- Groups split into control, TBI with normal interhemispheric (IH) transfer, and TBI with slow IH transfer groups (Babikian, et al., 2017)
- Age 8 to 18; whole brain magnetic resonance spectroscopy
- Dose response reductions in NAA in corpus callosum (CC; white matter tracts) in TBI
- NAA levels > in controls > normal IH group > slow IH group at 3 months post TBI

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Secondary Effects of Closed Head/Brain Injury

- At 12 mo post, choline levels in those with normal IH transfer were higher in the frontal/parietal regions
- Controls had higher cerebellar choline (=signs of development) levels in cerebellum vs slow IH TBI group
- NAA levels lower in slow IH group vs normal IH group and controls
- NAA levels in body of CC in normal IH vs slow IH group
- Chronic levels of CC choline and NAA negatively correlated with cognitive scores at 3 and 12 mo

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Secondary Effects of Closed Head/Brain Injury

- In moderate to severe TBI with slow IH transfer=reduced NAA (neuronal loss), impacts function of oligodendrocytes and myelin, doesn't normalize by 12 mo post TBI
- Therefore, those with slow IH transfer show poor neurometabolic signs of recovery/repair

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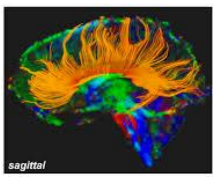
Secondary Effects of Closed Head/Brain Injury

- TBI kids with normal IH show a very similar initial pattern of neurometabolic deficits
- BUT, different pattern emerges at 12 mo post
- Show increased NAA levels in CC and continued lobar and CC choline increases, which suggests ongoing myelination, cell proliferation, and cell membrane repair



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Mediating Variables for Outcomes

- Timing, nature, severity of insult; repeated mild TBIs over an extended period of time can result in cumulative deficits; repeated mild TBIs over a short duration can be catastrophic or fatal
- Age at insult
- Location and extent of insult
- Functional plasticity
- Diagnosis, treatment, and management
- Control over secondary consequences-level of medical care and intervention

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Closed Head Injury

- Accounts for 90% of pediatric TBI
- Diffuse axonal injury is the result of shearing of the white matter and gray matter due to the acceleration/deceleration of the brain, seen in car accidents or child abuse
- Early seizures right after TBI are more prevalent in children (39% vs 22% in adults). Continued seizures observed in 3-5%, which complicates the picture for already impaired children
- Types of closed head injuries
  - concussion
  - classical cerebral contusions
  - diffuse axonal injury
  - shearing effects

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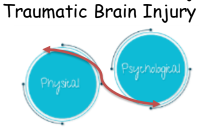
Post-Concussive Syndrome (PCS)

- Symptoms can appear immediately or can emerge weeks after the initial injury. Their severity lessens progressively over time, but the symptoms tend to change over time as well:
  - symptoms are most commonly of a <u>physical/neurological</u> nature immediately following the injury,
  - but tend to become predominantly <u>psychological</u> when symptoms persist over longer timeframes
- The DSM-5 no longer has a specific PCS diagnosis. This has been recoded under the Minor/Major Neurocognitive Disorder due to Traumatic Brain Injury



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Post-Concussive Syndrome (PCS)

- Signs and symptoms such as
  - sensory sensitivity to noise, sound,
  - problems with concentration,
  - short-term and long-term memory problems,
  - irritability, depression, anxiety,
  - fatigue,
  - recurrent headaches/migraines
  - and poor judgment
- may be called 'late symptoms' because they often emerge days or weeks later.
- Nausea, drowsiness commonly occur as long as two to four weeks after concussion; in PCS they remain
- Also, headache and dizziness occur immediately after the injury <u>and</u> can be long lasting as a late symptom

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Severity of TBI: Mild

- 80-90% of all actual brain injuries (including concussions; Emery, et al, 2016)
- Most recover on external examination within hours or days.
- Mild TBI/concussion often goes unreported and must be directly queried in parent and child interview
- May have problems over time (e.g., headache, attention, memory, fatigue, emotional problems) that are subtle or difficult to detect, especially with high premorbid functioning.
- Canadian research suggests that 12-14% of children with mild TBI will have post-concussive symptoms 3 months later (Faul et al, 2010)

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Severity of TBI: Moderate

- 8-10% of all brain injuries
- 3 months post-injury 2/3 have not returned to normal baseline range of activities
- 33-50% have residual problems (e.g., initiation processing speed, memory, temper, poor planning)

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Severity of TBI: Severe

- Less than 10% of all brain injuries
- Strong constellation of neurocognitive, emotional/behavioral, physical problems
- More likely to be socially isolated and suffer from subsequent psychiatric problems
- Likely greater long-term impairment

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Outcome Predictors for Specific Injuries

- Duration of coma
- Post-traumatic amnesia (PTA), presence and duration
- Age
- Location of injury, extent of damage
- Pre-injury functioning
- Support systems in school, family

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Outcome Predictors: Post Traumatic Amnesia (PTA)

- Period of time required for the child to remember past events
- Longer PTA= more severe head injury and often, worse prognosis
- Research has indicated that reading impairments are correlated with PTA> 1 hour

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Outcome Predictors: Coma and PTA

- Children with longer comas and/or longer PTA have been found to demonstrate more behavioral changes, academic deficits, and neuropsychological problems.
- 50% of children with comas exceeding 6 hours show deficits up to 2 years after recovery.

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TOP TEN CHANGES AFTER BRAIN INJURY (in no specific order)

1. Mobility
2. Communication
3. Memory
4. Attention
5. Processing speed/reaction time
6. Problem solving/planning
7. Cognitive fatigue
8. Judgment
9. Emotional/ behavioral control
6. Initiation/ Inhibition

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Impact of Brain Injury in Children

- TBI derails the developmental process.
- Problems may go unnoticed until the child starts having problems in school.
- Brain injury (and concussion) in children is under-identified.

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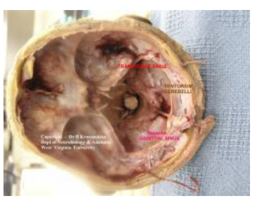
Let's Consider.....

- This is what the inside of your skull looks like....
- Why is this important?
- The brain is essentially the consistency of a firm Jello mold. Forces pushing and pulling the brain across these bony ridges impact neurocognitive deficits.



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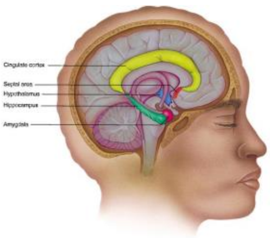
The Limbic System



- Main organs: hippocampus, amygdala, hypothalamus
- Hippocampus: memory retrieval
- Amygdala: emotional processing, integration of emotion and memories
- Hypothalamus: controls hunger, thirst, sleep, body temperature, hormones; important role in emotional regulation

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The Temporal Lobe

- Receives, analyzes, and integrates auditory information
- Center for language (expressive and receptive)
- Forms memories (but doesn't hold them)
- Dysfunction in this lobe could impact the whole brain
- Verbal Memory Video

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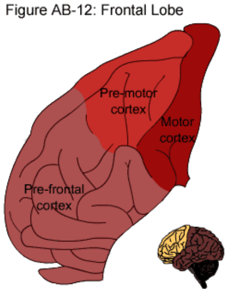
The Frontal Lobes

Figure AB-12: Frontal Lobe



- Susceptible to injury
- Control executive functions
- Deficits may become apparent as student develops- "grow into a deficit"
- Motor cortex

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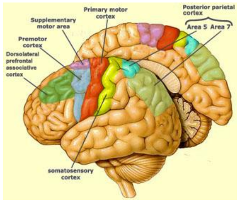
Executive Functioning: Skeletomotor Circuit

Development of the frontal lobes progresses from posterior (back) to anterior (front) with five major neural pathways

- the skeletomotor circuit originates in the motor and premotor cortices and the parietal somatosensory cortex.
- damage to this particular circuit coincides with akinesia and bradykinesia (movement disorders)



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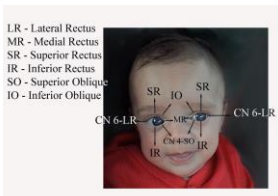
Executive Functioning: Oculomotor Pathway

- The second pathway, the oculomotor circuit, begins in the frontal and supplementary eye fields and includes a striatal component in the body of the caudate nucleus.
- Dysfunction results in difficulty with voluntary visual fixation and maintenance of eye gaze (hummingbird eyes)



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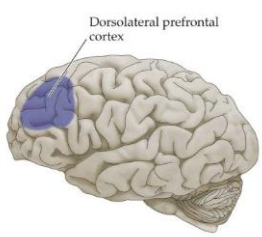
Executive Functioning: Dorsolateral Prefrontal Cortex

- The third pathway, the dorsolateral prefrontal circuit, originates in the dorsolateral prefrontal cortex
- Damage leads to dysexecutive syndrome
  - difficulty maintaining or shifting set,
  - organizational strategizing,
  - active retrieval of memories, and
  - fluency (both visual and verbal)



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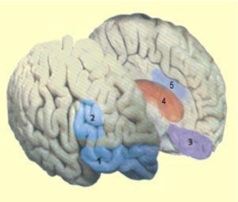
Executive Functions: Lateral Orbitofrontal Circuit

- The fourth pathway, the lateral orbitofrontal circuit, begins in the inferolateral prefrontal cortex
- Important in aspects of
  - personality,
  - social restraint,
  - empathy,
  - behavioral inhibition,
  - self monitoring



1) Orbitofrontal region

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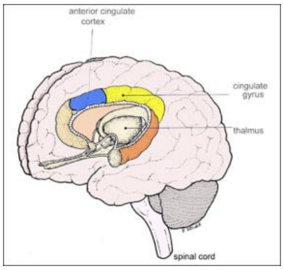
Executive Functions: Anterior Cingulate

- The final circuit is the anterior cingulate circuit, which originates in the anterior cingulate.
- Damage in this pathway is associated with
  - apathy,
  - reduced initiation
  - akinetic mutism.
- The anterior cingulate is thought to modulate
  - response intention,
  - focused attention,
  - response selection and control.



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TBI and Attention

- Consistent research has pointed to inattention as being one of the most widely observed and debilitating cognitive sequelae post-TBI.
- Research suggests that for TBI occurring between 2-7 yo, attention deficits persisted at 5 years post (Babikian et el. 2015)
- Secondary ADHD dx is made in 15-20% of children, may resolve, more persistent in severe TBI
- The combined factors of slowed processing speed and impaired attention and concentration is the hallmark of severe TBI.
- There appears to be a dose-response relationship (still present at 2 yrs and beyond). Processing speed improves over time but there are more likely residual problems as the severity of the injury increases.

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TBI and Attention

- Although research has suggested that divided attention (multi-tasking) is particularly problematic in these children, others posit that it is really a processing speed problem.
- It is suggested that the most problematic performance is seen when attention, processing speed, and mental flexibility converge.

Executive Functions

- Working memory (Gorman, et al., 2017)
- Major impacts on WM were age at injury and injury location
- Kids with TBI had a slower rate of verbal WM recovery (leads to increasing gap over time)
- Children injured at younger ages with increased severity had the slowest recovery rate
- Children between 6 and 8 yo made fewer gains over 2 yrs, with 9 yo + making greater gains (more intact baseline fx)

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Executive Functions

- Working memory (Gorman, et al., 2017)

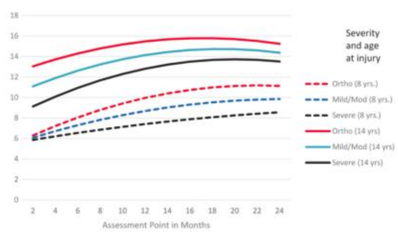

Figure 1.
Expected verbal working memory by severity and age at injury. Dotted lines represent children injured at a younger age by orthopedic, mild/moderate and severe injury groups. Solid lines represent children injured at an older age of same injury severity groups.

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Trajectory of Attention and Processing Speed Deficits

- Babikian, et al. (2015)
- Mild TBI-negligible attention and small processing speed (PS) deficits initially, with PS significantly improved at 2 yrs post
- Mod TBI-small and consistent indications of attention deficits-persistent at 2 yrs; large initial deficit in PS but reduced to small deficit by 2 yrs
- Severe TBI-mod to large attention deficits that persisted to 2 yrs; PS deficits large initially and only mild improvement over time
- In teens-generally sustained attention skills intact at 18 mo but PS and shifting attention deficits present and persistent

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Trajectory of Attention and Processing Speed Deficits

- Babikian, et al. (2015)
- Similar patterns seen in state EOY testing, with increased impacts on social/emotional functioning and social/cognitive development in adolescents
- Due to disruption and disconnection in connections between prefrontal, parietal, and superior temporal regions
- This results in reduced interpersonal problem solving and social perspective taking; also impacts self-awareness (medial PFC and posterior cingulate)
- Outcomes further linked to 1) family fx, 2) IQ, and 3) # of interventions received

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Academic Behavior

- Treble-Barna, et al. (2017)
- Assessed children 3 to 7 yo at 6, 12, 18 mos post TBI
- Additional studies from the same cohort reflected fx at 3.5 yrs post and transition to adolescence at 7.5 yrs post
- Used NP testing, parent and teacher EF ratings, and classroom observations

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Academic Behavior

- Treble-Barna, et al. (2017)
- Results suggested NP deficits related to severity (GCS)-reduced response inhibition, fluid reasoning, FSIQ, and pragmatic language
- Younger age at injury=reduced verbal fluency and fluid reasoning
- Lower GCS=increased teacher focus in observations
- Decreased EF=increased teacher focus in observations
- Decreased cognitive flexibility=increased off-task behavior

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Academic Behavior

- Treble-Barna, et al. (2017)
- Increased parent EF concerns=reduced academic task management
- Increased academic performance (teacher rated)=better verbal skills, WM, FSIQ, pragmatic language, processing speed, and correlated with lower EF concerns
- Increased fluid reasoning=increase teacher reported academic performance (protective mechanism)
- Those with reduced fluid reasoning should be targeted for earlier and more intense academic supports

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Social-Emotional Impairments

Social-emotional changes after a neural insult appear to occur in three different ways:

1. Neuropsychological-organic brain damage/cognitive changes or alterations in the structural, neural connections, or neurotransmitter systems
2. Reactionary-adjustment style changes-long-term psychological impacts due to nonstructural changes involving behavioral problems (social skills deficits, independence)
3. Characterological- exacerbation of premorbid problems or prior personality traits or “baggage” brought up by the experience

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Social-Emotional Impairments

- Childhood psychopathology does not differ significantly in its presentation when observed due to biological predisposition compared with those who struggle after TBI
- The difference lies in the differential diagnosis
- Many of the behavioral sequelae of acquired injuries mask, exacerbate, or mimic other more classic psychopathological signs
- This increases the prevalence of ED designations in TBI when not considered or reported

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Social-Emotional Impairments

- Types of psychological responses seen following TBI
  - Anxiety or "catastrophic reaction"
  - Emotional lability/disinhibition
  - Paranoia and psychomotor agitation
  - Denial
  - Depression
  - Social withdrawal
  - Reduced motivation, initiation, and independent forward movement toward goals

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Social-Emotional Impairments

- Seizure disorder may exacerbate irritability and behavior dyscontrol, cause additional brain damage.
- Cognitive problems, especially memory, affect emotional response.
- Denial of deficits may affect capacity to receive help.
- Previously effective medications may not work or may exacerbate injury-related problems.
- Depression/aggression may prevent participation.

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Social-Emotional Impairments

- The role of severity in predicting novel psychiatric disorders after TBI is unclear;
- Both mild and severe TBI patients had the potential for behavior problems
- Some studies have found children with severe TBI tended to have higher rates of behavior problems.

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Social-Emotional Impairments

- A variety of possible psychiatric disorders are observed, including ADHD, ODD/CD, anxiety, depression, social withdrawal, and PTSD. Sometimes none of these are present
- Tentative research suggests TBI severity tends to predict ADHD, while pre-injury family dysfunction predicted ODD development
- Likely a mixture of neurological and psychosocial impacts

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Social-Emotional Impairments

- (Emery et al, 2016) Depression
  - review of pedi TBI research suggests that depression may be as much as 9.3x more prevalent in TBI at 6 mos post
  - by 2 years, mood swings reported at a higher rate but not necessarily clinical depression
  - rates are variable, as ortho impairments resulted in similar patterns of depression
  - may be more related to complicated adjustment to life changes after trauma/injury vs solely being attributed to TBI alone

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Social-Emotional Impairments

- (Emery et al, 2016) Take home
- Increased behavioral and psychiatric issues are present after mild TBI
- Greatest risk is for
  - those requiring hospitalization
  - when injury is prior to age 6
  - when child is still in acute window (6 mo)
  - when multiple prior TBIs are reported
  - when premorbid psych issues were present
  - and rates are largely related to contrast group in research; similar patterns in ortho injuries (trauma alone)
  - self ratings more sensitive than interview

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Social-Emotional Impairments

- Anxiety after TBI increased in acute window (usually around 6 mo) but not at 12 and 24 months beyond standard rates
- Clear indications of behavioral issues post TBI. Rates of ODD and CD appear to be more related to premorbid dx, trauma factors separate from TBI, history of multiple TBIs, and severity/hospitalization
- PTSD not higher-trauma in general not TBI predicts
- AU-nothing clear
- Schizophrenia-increased with premorbid family risk and injury prior to age 11
- Substance abuse-mild TBI 3x more likely to abuse substances when hospitalization was required

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Trajectory of Social/Cognitive Deficits

- Babikian, et al. (2015)
- May observe remarkable early recovery but then TBI groups "hit a wall" or plateau and fail to meet later cognitive and developmental milestones (impacting independence)
- In standardized assessment (IOWA, Stanford) children show a partial return to baseline in formal testing scores, but at 2, 5, and 10 yrs post, although their IQ score may be average, they continue to struggle and fall farther behind academically and socially

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Social Emotional Trajectory

- Ryan, et al. (2016)
- Completed WASI, CBCL, and family fx scales in TBI children 5-15 yo at 12 and 24 mo post
- Severe TBI kids showed significant increases in social problems at 24 mo vs levels at 12 mo and in contrast with controls and mild/mod TBI kids
- Mild/mod TBI kids showed mild but stable problems over time
- Variance was significantly explained by post TBI caregiver mental health and family fx
- Poorer outcomes in social fx were present with family dysfunction and poorer parental mental health at 24 mo

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Social Emotional Trajectory

- Ryan, et al. (2016)
- Providers should attend to ways to optimize home environment and bolster family coping resources (improve child recovery)
- Deficits in social fx theorized to be impacted by
  - poor adaptation to new limitations
  - possible disruption of white matter connections in social network
  - failure to make gains in skills that are not mature at time of injury
  - microstructure changes in corpus callosum reduced TOM, empathy, emotional recognition=reduced social fx

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Social Emotional Trajectory

- Ryan, et al. (2014)
- TBI often impacts anterior regions thought to house aspects of social cognition network; DAI disrupts white matter connections
- Research suggests deficits in
  - processing emotional faces
  - prosody
  - recognizing/labeling big 4 emotions
- Some rebound is noted between acute and 18 mo post, they do not increase to control levels

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Social Emotional Trajectory

- Ryan, et al. (2014)
- with injury between 1 and 7 yrs, follow up 16 years later
  - TBI sample less able to decipher emotion when incongruent messages were present (sarcasm)
  - overly literal interpretation relying on verbal content (white matter connections between right and left?)
  - severe TBI group struggled to ID facial emotions, integrate visual and auditory cues
  - injury factors were linked
    - increased severity
    - volume of posterior CC and frontal pathology
    - resiliency when high SES and high family intimacy present (more practice?)
    - NP battery should include social perception and cognition components

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Family Factors

- Research has suggested that family functioning is a large moderating variable when considering patient outcome.
- Findings suggest a tentative link between family factors and cognitive outcome.
- Studies support that variables such as low level of family stress and better adaptability to change have been positively correlated with psychosocial outcomes.

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Family Factors

- Family variables should be determined over time, as family functioning at 6 months post-injury is not the same as at 2 years (consider support fatigue).
- Family factors such as low SES and the number of family stressors tend to remain more predictive of outcome in the long run than severity or lesion location (put on your social worker hat)

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Assessment: Role and Function

- Psychologists often have a unique position in their ability to assess a broad range of neurocognitive domains and then translate findings to individualized intervention
- ASSESSMENT IS AN INTERVENTION
  - the professional may reframe perceptions, adjust family expectations, motivate the patient/family/teachers, address caregiver adjustment and emotions, and provide prevention of secondary disorders

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Assessment-When, Why, and How

- Diagnosis-
  - Exploration versus diagnostic testing
  - How close? What do your scores actually tell you?
  - What is NEED to know versus WANT to know
  - Can you pull data from other sources?
  - Who should be included on the team?
  - Assessment is like a home inspection

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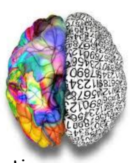
General Considerations



- Multidimensional Assessment
- Gathering Information
  - medical needs and effects of medication
  - child's ability to perceive test stimuli
  - special positioning needs
  - behaviors that may interfere with testing
  - ability to communicate

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Considerations Continued

- Parental Involvement in Assessment
  - these are the experts on the child from before and the most likely to notice more subtle deficits versus a teacher. It is easy to focus on school staff because they are available and kind of forced to fill out paperwork. Don't be short-sighted; be diligent
- Testing Session
  - length
  - short sessions with frequent breaks
  - modification of task demands
  - modification of response

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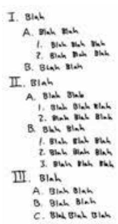
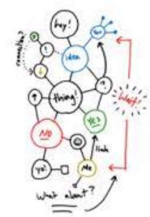
Assessment Considerations

- Areas that should be measured, either directly or qualitatively
- Foundational skills
  - Basic receptive language/listening comprehension
  - Oral expression
  - Verbal fluency
  - Basic visual perception
  - Visual-motor integration
  - Visual scanning/processing speed
  - Fine motor skills/sensory processing





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Assessment Considerations

- Foundational skills continued
  - Attentional capacity (auditory and visual for all)
  - Selective attention
  - Sustained attention
  - Divided attention/multitasking
- Complex skills
  - Intellectual functioning (with appropriate interpretation)
  - Academics including fluency in all areas
  - Memory/learning (thorough on this one)
  - Executive functioning
  - Social/psychological/behavioral

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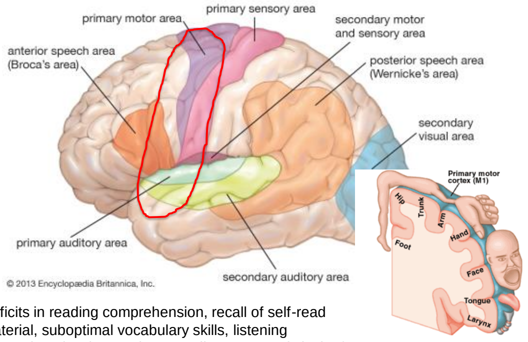
Assessment Example

- Severe TBI Example
  - Original brief assessment
  - Second full evaluation
    - Discussion points
      - Components of both types of assessment
      - Team member inclusion/options
      - Timing
  - Documents used: Severe TBI Original Brief Scores; Severe TBI Example Report

Assessment Example

- Mild TBI/Post-Concussive Syndrome Example
    - Discussion points
      - Do you watch Gold Rush? Like drilling pilot holes
      - Seek to link and expand (is there something adjacent?)
  - Documents used: PCS Sample Report

Visual Overview of NP Findings



Deficits in reading comprehension, recall of self-read material, suboptimal vocabulary skills, listening comprehension (versus intact auditory memory), lack of control of right eye lid, occasional slurring of words with fatigue

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General Recommendations

- One of the most problematic effects of a brain injury is cognitive fatigue. Most children with TBI are less able to sustain mental energy and attention when compared with peers. Tasks involving rote work or drills should be kept to a minimum.
- New material should be linked to material that is already known in order for learning to occur.
- Increased repetition of a new skill may be required for the child to retain what is being taught.
- Help the child to focus their attention on the important parts of the task. This can be accomplished by using words that verbally indicate that the material or skill being taught will be used again.
- It may be helpful to connect new learning with real life examples so as to enhance their importance. For example, practicing money skills by setting up a “store.”
- Break complex tasks or ideas into small simpler parts to facilitate learning.

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General Recommendations

- Priority seating may be helpful. A seat near the board may keep the child focused on the instruction rather than on others seated around them.
- Teaching lessons that are varied and brief keep the child interested and decrease “wandering” from the task at hand.
- Cooperative learning tasks or group activities may allow the child to feel successful while allowing them to develop much needed social skills.
- Larger type and contrast on worksheets can be helpful for these children. It may also be helpful to limit the number of items on a page and focus on mastery rather than practice.

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General Recommendations

- It may be helpful to put different types of tasks on different worksheets in order to minimize confusion and allow for comprehension of instructions. For example, put all addition problems on one sheet and all subtraction problems on the next. What are you trying to measure? Isolate and eliminate obstacles
- Use of visual aids paired with type can also be helpful to acquiring new skills.
- When you put two or more types of tasks on one page, it may be helpful to use a bold line or “stop sign” to separate the tasks into sections.

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General Recommendations

- Children with TBI will benefit from frequent reminders to check their own work before indicating that they are finished or turning work in. This can be used as a great opportunity of the teacher to model the correct way to complete a certain task.
- Classroom rules should be clearly posted and referred back to when a child has made an infraction of those rules.
- Problematic behavior can be monitored through charting and positive rewards for decreases in target behavior. This may take the form of a sticker or point system for good behavior.

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General Recommendations

- It would be extremely helpful to allow the child real choices regarding the type of work they complete or the order in which it is to be completed. For instance, allow them to choose between subjects, work media, or style of presentation.
- More time should be provided for completing all tasks due to the decreased processing speed that often accompanies TBI.
- Lengthy verbal directions should be avoided. It may be helpful to provide instructions in step so that the child is able to retain what they are supposed to do first, and then give further instruction when the first step has been completed.

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General Recommendations

- When giving directions for independent work, it may be helpful to request that the child retell the instructions so that you are able to check for comprehension before they start.
- Children with TBI may require more short breaks. If they are capable, they can be very useful in delivering messages, doing short errands, or passing back work.
- Children with TBI should be allowed to work in a quiet environment that allows them to focus their attention at the task at hand rather than the commotion in the room.

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General Recommendations

- Memory skills such as mnemonics and chunking can be taught to these children to help with memory deficits.
- Children may also benefit from instruction in rehearsal or verbal repetition of information to be remembered.
- Routine should be consistent when possible to allow the child to predict what will happen next in their day.

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Useful Sources

- Bibliotherapy, psychoeducation, and intervention www.lapublishing.com

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Useful Sources

- General resources
  - http://www.neuroskills.com/children.shtml

114

Useful Sources

- General resources
  - http://bianys.org/resources.htm

115

Useful Sources

- Education for yourself, teachers, and parents
  - www.projectlearnet.org

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Brain Injury Association of New York State (BIANYS)
http://www.projectlearnet.org/tutorials.html

Family Issues (Click HERE to Download a PDF)
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Self-Monitoring and Self-Evaluating (Download PDF)
Flexibility Versus Rigidity In Thinking and Behavior (Download PDF)
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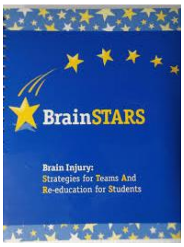
TBI Specific Materials



- https://www.brainline.org/article/brainstars

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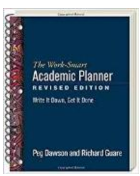
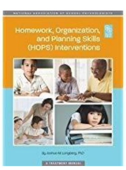
Academic Organization





- Possible consideration for a ready-made planner to structure and support
- School-based academic organization program (NASP)

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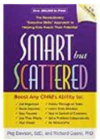
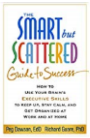
EF Books and Materials





- Go to EF book to support kids with all kinds of EF deficits (ADHD, AU, LD, OHI, TBI)
- Options for younger kids, teens, and adults

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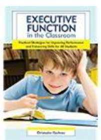
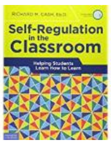
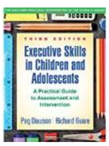
EF Books and Materials







- Additional options more targeted for classroom implementation/teacher guidance
- Many of the most effective supports for executive dysfunction are environmental

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Insert Hearty Applause Here