Online Learning Modules:
Understanding the Brain

COLORADO
Department of Education

Provided by:
The Exceptional Student Services Unit
Brain Injury Team

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Brain Injury 101:
Laying the Framework

COLORADO
Department of Education

Nicole Crawford, Ph.D.
CDE Brain Injury Specialist

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Speaker: Nicole Crawford, Ph.D.

- Brain Injury Specialist-Colorado Department of Education
- Dually licensed School Psychologist and Clinical Psychologist

Experiences:
- School Psychologist for nearly 20 years
- Brain Injury Team facilitator and co-facilitator
- Brain Injury Educator Liaison
- Traumatic Brain Injury Network Team Planner
- Private Practice- complete neuroeducational assessments

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Objectives

What is a Brain Injury?

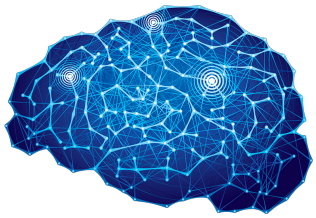
Brain Anatomy and Impact of Injury

Effects of Brain Injuries

Statistics and Prevalence Rates of TBI

Brain Development and Influence on Brain Injuries

Further Your Learning



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Congenital Brain Injury

Influences on the brain that occur during pregnancy or birth

- Prenatal substance exposure
- Infections during pregnancy
- In-utero stroke
- Hydrocephalus
- Microcephaly
- Neural tube deficits
- Genetic disorders
- Injuries as part of the birth process

Congenital Brain Injury is **not** an Acquired Brain Injury

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Types of Acquired Brain Injury

An **Acquired Brain Injury** (ABI) covers ALL post-birth injuries to the brain – including both non-traumatic such as anoxic (lack of oxygen to the brain), or toxic (introduction of toxins or chemicals to the brain) and traumatic (external blows to the head from an outside source). Regardless of the cause of the brain injury, consequences of brain injury may be similar, and the interventions may be the same.

Traumatic Brain Injury

A Traumatic Brain Injury (TBI) is a type of acquired brain injury that is a result of an external blow to the head, an acceleration/deceleration injury, or a blast injury.

Non-Traumatic Brain Injury

A Non-Traumatic Brain Injury includes all post-birth injuries that do not fall under the definition of a TBI and can include events such as strokes, toxins, and lack of oxygen to the brain

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Acquired (Post-Birth) Brain Injury

Traumatic – External Force

- Falls
- Motor Vehicle Accidents
- Bicycle/Pedestrian
- Assaults/Abuse (e.g., Abusive Head Trauma/Shaken Baby Syndrome

It is estimated that 1,000-1,500 children the U.S. sustain Abusive Head Trauma each year.

Non-Traumatic – Internal Event

- Illness (e.g., high fever)
- Infections (e.g., meningitis, encephalitis)
- Anoxic injuries (lack of oxygen; e.g., airway obstruction, near drowning)
- Stroke or vascular events (lack of blood flow)
- Brain tumors, malformations
- Poisoning (e.g., ingestion, inhalation)
- Metabolic disorders (e.g., insulin shock)

Centers for Disease Control and Prevention Traumatic Brain Injury and Concussion Statistics 2006-2014
https://www.cdc.gov/traumaticbraininjury/data/index.html
https://www.ncbi.nlm.nih.gov/books/NBK499836

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Types of Brain Injury or Impact & **Special Education Considerations**

Brain Impact/Injury

Acquired Brain Injury (acquired after birth)

TBI

OHI…

Traumatic

Non-Traumatic

Congenital (before birth/pre-natal)

OHI

e.g., Fetal Alcohol Spectrum Disorder, etc.

Similar impacts and interventions

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Classifications of Traumatic Brain Injuries

- Medical Definition of TBI
  - Loss of Consciousness (LOC)
  - Post-Traumatic Amnesia (PTA)
  - Glasgow Coma Scale

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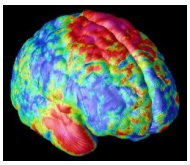
Classifications of Traumatic Brain Injuries



- Mild TBI (LOC <30 min; PTA< 24 hours)
  - Concussion
  - Complicated Mild TBI
- Moderate TBI (LOC >30 min <24 hours; PTA 24 hours-7days)
- Severe TBI (LOC > 24 hours; PTA more than 7 days)

The severity of the injury does not solely determine the long-term impact on functioning.

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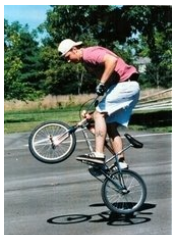
Children aged 0 -4 years



Older adolescents aged 15-19 years

Adults aged 65 and older

Age Groups Most Likely to Sustain TBI

(CDC, 2018)

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Common Causes of TBI

Infants: Falls and Abuse

Young Children: Falls, Passengers in vehicles

School-aged Children: Bicycle and pedestrian collisions with vehicles

Adolescents: Drivers and passengers in motor vehicle accidents, assaults, falls

Centers for Disease Control & Prevention

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The Brain

- Adult brain weighs approximately 3 pounds
- Consistency of firm Jello
- Surrounded by cerebral spinal fluid
- 3 membranes (meninges) protect the brain and spinal cord
  *Pia Mater *Arachnoid *Dura Mater
- Interconnected–no area works by itself
- Body sends 11 million bits per second for the brain to process

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Each neuron communicates with many other neurons to form circuits and share information

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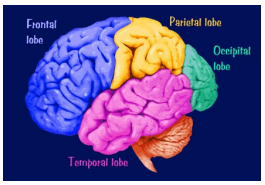
Simplified Brain Behavior Relationships

Frontal Lobe
- Initiation
- Problem solving
- Judgment
- Inhibition of behavior
- Planning/anticipation
- Self-monitoring
- Motor planning
- Personality/emotions
- Awareness of abilities/limitations
- Organization
- Attention/concentration
- Mental flexibility
- Speaking (expressive language)



Parietal Lobe
- Sense of touch
- Differentiation: size, shape, color
- Spatial perception
- Visual perception

Occipital Lobe
- Vision

Cerebellum
- Balance
- Coordination
- Skilled motor activity

Temporal Lobe
- Memory
- Hearing
- Understanding language (receptive language)
- Organization and sequencing

Brain Stem
- Breathing
- Heart rate
- Arousal/consciousness
- Sleep/wake functions
- Attention/concentration

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Anatomy of a Traumatic Brain Injury

- Closed Head and Open Head Injuries
- Coup and Contrecoup
- Axonal Shearing
- Metabolic Imbalance
- Bruising/Bleeding
- Swelling-Intercranial Pressure
- Misconceptions
  - All brain injuries can be observed through neuroimaging

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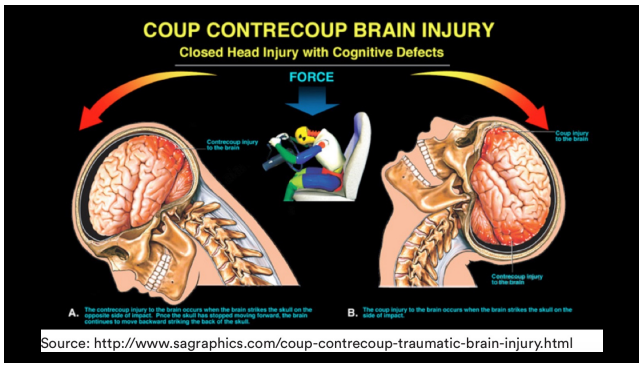

Source: http://www.sagraphics.com/coup-contrecoup-traumatic-brain-injury.html

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What Happens During a Coup Contrecoup Injury?

youtube.com/watch?v=yPCr5yQDOLs

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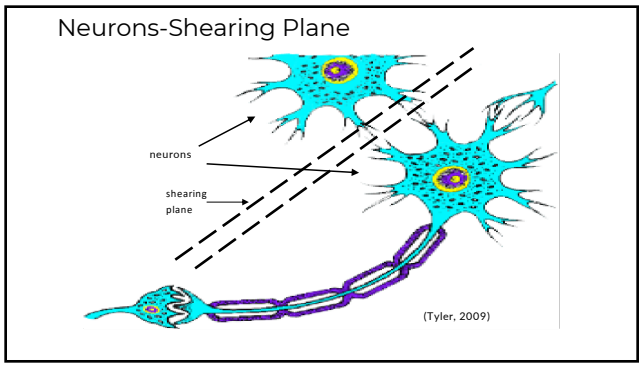
Neurons-Shearing Plane
neurons
shearing plane
(Tyler, 2009)

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Medscape ©
http://www.medscape.com

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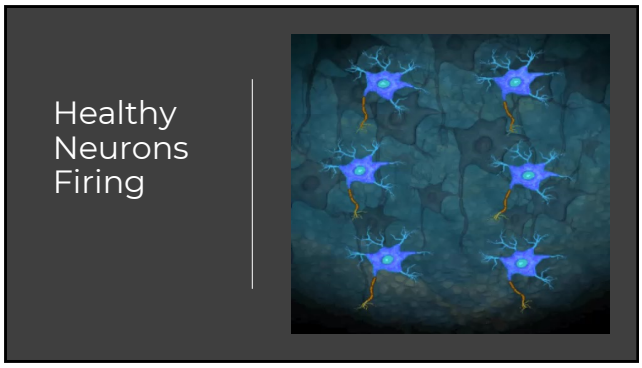
Healthy Neurons Firing

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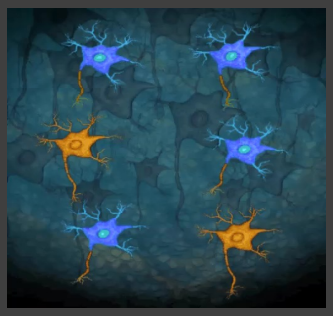
Damaged Neurons Firing



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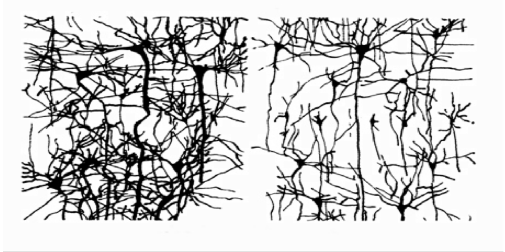
Effects of Injury Before and After



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Brain Injury Outcomes

Every brain is unique based on the history of the injury and presenting needs of the individual

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Physical Symptoms of TBI

- Headache/Pressure
- Blurred Vision
- Dizziness/Poor Balance
- Ringing in the ears
- Seeing "stars"
- Vacant stare/Glassy eyed
- Nausea/Vomiting
- Numbness/Tingling
- Sensitivity to light/noise
- Disorientation
- Neck pain
- Fatigue-physical and cognitive

https://reapconcussion.com

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Physical Symptoms Moderate to Severe Injury

- Paralysis or spasticity
- Weakness on one or both sides of body
- Problems swallowing
- Seizures
- Vision deficits
- Sleep disorders
- Pain
- Regulating body temperature, blood pressure, or breathing
- Decreased Fine and/or Gross Motor Skills
- Medication side effects

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TBI is a Chronic Disease

- TBI is a lifelong health condition
- Following a moderate to severe brain injury, individuals are at increased risk of developing
  - Seizures/Epilepsy (1.5-17 times)
  - Neuroendocrine Dysfunction/Hypopituitarism (30%)
  - Thyroid Dysfunction/Hypothyroidism (5%)
  - Gonadal Hormone Dysfunction/Precocious puberty
  - Alzheimer's-Type Dementia (moderate 2.3x risk; severe 4x risk)

(DePompei, 2013)

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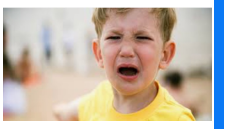
External Behavioral Impacts



- Rapid mood changes
- Impulsivity
- Easily agitated and upset
- Low frustration tolerance
- Argumentative
- Attention seeking
- Limited insight into own behaviors
- Misperceive situations or behaviors of others
- Not learning from mistakes
- Risk taking behaviors

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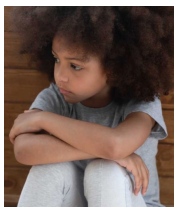
Internal Behavioral Impacts



- Withdrawn
- Flat affect
- Unmotivated
- Appears depressed or anxious
- Difficulties with social skills
- Few or no friends

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Cognitive Impacts

- Sensory/Motor
- Processing Speed
- Memory
- Attention and Concentration
- Inhibition
- New Learning
- Expressive and Receptive Language
- Visual-Spatial Processing

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Cognitive Impacts

- Executive Functions
  - Initiation
  - Organization
  - Planning
  - Mental Flexibility
  - Reasoning- Problem Solving, Judgement

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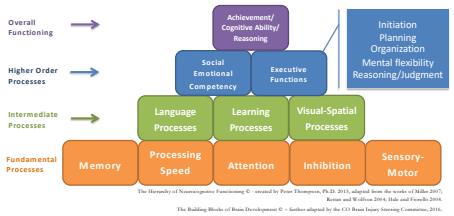
Building Blocks of Brain Development ©



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Factors that Impact Outcome

- Pre-injury functioning
- Severity of Injury/Location of Injury in the Brain
- Pre-existing conditions
  - Learning disabilities, ADHD, mental health, behavioral needs
  - Prior TBIs, headaches, sleep disorders

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Factors that Impact Outcome

- Family SES
- Family functioning
- Availability of pediatric trauma centers and other specialized TBI medical services and rehabilitation
- Child's age and developmental level

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TBI Statistics and Facts

Conservatively, 7 million U.S. school children (ages 5-15) have experienced some form of brain injury

Corrigan, Selasse, & Orman, 2010

145,000 children (ages 0-19) are currently living with a long-lasting, significant alteration in social, behavioral, physical, and cognitive functioning from a TBI

Nagele, et al., 2019

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TBI Statistics and Facts

- Traumatic Brain Injury (TBI) is a leading cause of death and disability among children ages 1 to 19 years in the United States (Faul, Xu, Wald, & Coronado, 2010).
- Each year, approximately 40 percent of TBIs in the United States occur in the pediatric population (ages 0–19 years) (Faul et al., 2010).

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Incidents of TBI: National Data

CDC 2014 TBI Related Annual Report

Children Ages 0-14:

- 837,000 emergency department visits
- 23,000 hospital stays
- 2,529 deaths

These numbers do not include children who sustained a TBI and did not seek medical care, sought care through PCP, or were treated and released from ED without mention of potential TBI

Severity of TBI in Emergency Department Visits (Rivara, Koepseel, Wang 2011)

- Mild 70-90%
- Moderate 13%
- Severe 2%

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TBI Demographics

- After infancy, males are injured twice as frequently as females
- African American, Hispanic, and Native American children are more likely than white children to experience a more severe TBI and have higher mortality rates (Falcone, Marin, Brown, Garcia, 2008; Howard, Joseph, Natale, 2005)

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Brain Injury Disability in Children

- 61% of children with a moderate to severe TBI experience a disability
- 14% of children with mild TBI experience a disability

Rivara, Koepseel, Wang, et al 2012

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U.S. Department of Education Data

- During the 1991-92 school year, there were a total of 4,499,824 students receiving special education services. Of that total, only 245 were served under the TBI disability category
- During the 2018-2019 school year, there were a total of 7,134,000 students receiving special education services. Of that total, 27,000 were served under the TBI disability category

ht https://nces.ed.gov/programs/digest/d17/tables/dt17_204.30.asp

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Comparison Across Disabilities

2018-19

Disability	Total Number
All	7,134,000
Autism	762,000
SLD	2,368,000
Emotional	358,000
OHI	1,049,000
TBI	27,000

https://nces.ed.gov/programs/digest/d19/tables/dt19_204.30.asp

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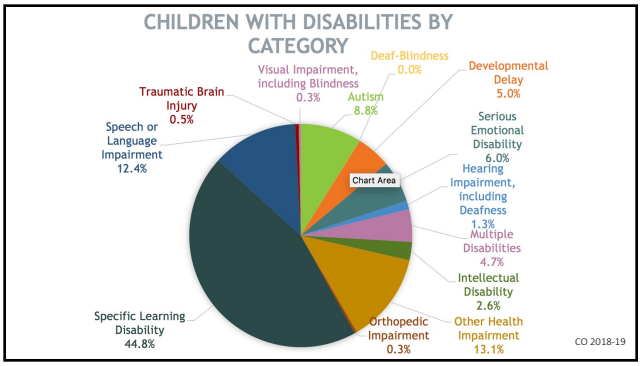

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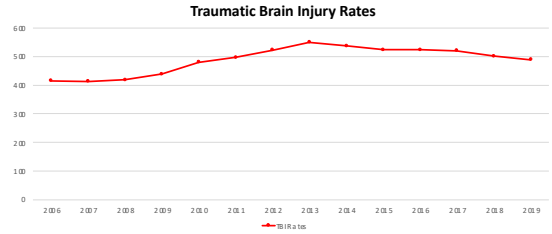
Colorado Special Education Eligibility Numbers-TBI



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Hmmmm???

- 61% of children with a moderate to severe TBI experience a disability and 14% of children with mild TBI experience a disability

  Rivara, Koepseel, Wang, et al 2012

- Then why…do the USDOE special education numbers report a mere .4% of students in special education?

  https://nces.ed.gov/programs/digest/d19/tables/dt19_204.30.asp

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Why Are We Missing These Children?

- Transition support from medical setting can be rare or poorly coordinated
- Medical focus is on survival and obvious physical injuries
- Treat and Release from the emergency department

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Why Are We Missing These Kids?

- The effects of brain injury can be very subtle
- Might not see the impact for years until cognitive demands increase
- Families and school personnel have limited knowledge about brain injuries
- Misidentified under learning disability, emotional disability, other health impaired (ADHD), etc.

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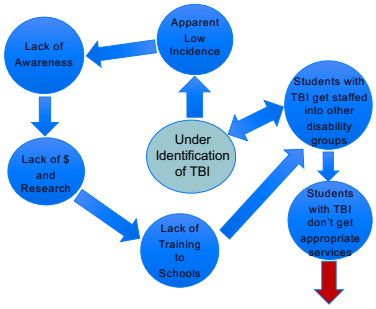

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What are the downstream consequences?

Children's Healthcare of Atlanta; Julie Haarbauer-Krupa, PhD & CDC TBI in Prisons and Jails: An Unrecognized Problem

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Mental Health Fallout in Early Injuries

- Compared to non-TBI and outpatient only, by early adolescence (age 10-13), those hospitalized with a mild TBI before age 6 were:
  - More hyperactive and inattentive according to parents and teachers
  - More likely to be identified with ADHD, conduct disorder, or oppositional defiant disorder
  - More likely to have substance abuse problems
  - More likely to demonstrate a mood disorder

John Corrigan- Ohio State University

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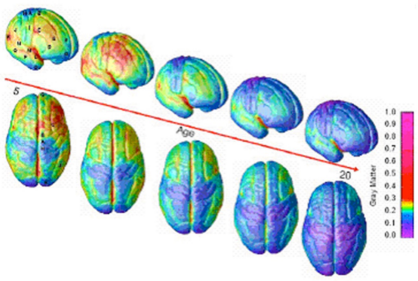
The Developing Brain



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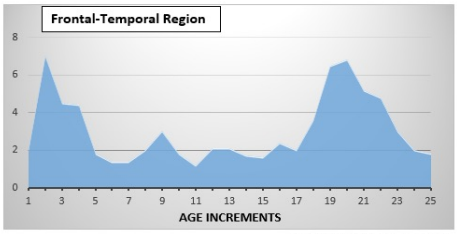
Maturation & Foundation - Executive Functions



(Adapted from Savage, 1999)

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Infancy Stage: Birth to 3 years

Developing:
- Refinement of sensory and motor systems
- Language acquisition
- Basic understanding of cause and effect
- Regulation of sleep-wake cycle
- Beginning awareness of self and others
- Emotions and emotional regulation

Disruptions:
- Poor sleep and self-regulation
- Lack of understanding of cause-effect relationships
- Impulsivity & uninhibited behaviors (e.g., biting, hitting)
- High reliance on structure, supervision; difficulty with transitions
- Emotional reactions are unpredictable, "irrational," and extreme.

BrainSTARS, Dise-Lewis, J., 2002

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Developmental Stages

- Abilities that are in a rapid state of development, or have not yet emerged, are the most sensitive and most likely to be disrupted.
- These areas are likely to be the "Achille's heel" for a child with an acquired brain injury, even after he/she grows up.

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TBI and the Developing Brain

Numerous studies have shown that young children (0-5) who experience a TBI are at greater risk for deficits than children injured at later ages.

Glang, Ettel, Tyler & Todis, Brain Injury Medicine, 2013

Moderate to severe TBI before 18 months can result in severe subsequent disability in oral language and intellectual ability at school age.

Vasse-Hitier, et al., Brain Injury, 2019

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Development Questions

- What is "typical" for their developmental level?
- What skills has the brain injury impacted?
- Was the child "typically" developing before the injury?

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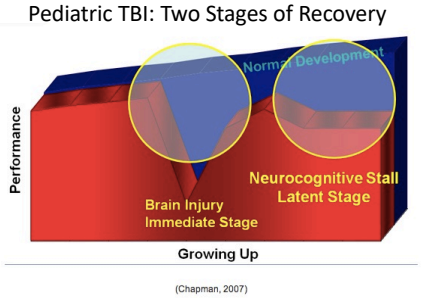
Pediatric TBI: Two Stages of Recovery



(Chapman, 2007)

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Take Aways

- Children with TBI are being under identified for services
- TBI is a chronical medical condition and can have life-long impacts
- Next Steps?

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Additional Brain Injury Modules

- Understanding the Building Blocks of Brain Development
- Brain Injury Special Education Eligibility
- Building Blocks of Brain Development: Classroom Strategies
- Understanding Brain Injury and "Can't versus Won't" Behavior
- Understanding the Intersection between Brain Injury and Mental Health Conditions
- And others

https://www.cde.state.co.us/cdesped/sd-tbi

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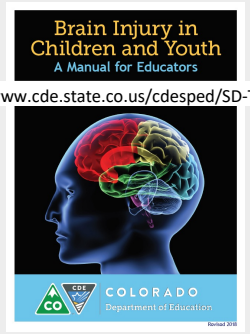

http://www.cde.state.co.us/cdesped/SD-TBI.asp

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www.COKidswithBrainInjury.com

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BrainSTEPS CO
Strategies Teaching Educators, Parents, & Students
A BRAIN INJURY SCHOOL RE-ENTRY CONSULTING PROGRAM

- Brain Injury School Consulting Program
- In many Districts/BOCES across the state
- Inter-disciplinary Consultation Team
- Trained in brain injury and The Building Blocks of Brain Development©
- Funded in partnership by:

COLORADO Department of Education | MINDSOURCE BRAIN INJURY NETWORK

For more information go to: http://www.cde.state.co.us/cdesped/brainsteps

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Brain Injury Alliance COLORADO

Services

- ❖ Education Consultation
- ❖ Resource navigation
- ❖ Outreach and education
- ❖ Juvenile/criminal justice
- ❖ Self-management & skill building
- ❖ Classes and workshops
- ❖ Recreation and social programs
- ❖ And more – when in doubt, refer to us!
- ❖ ALL AGES CAN ACCESS THIS FREE SUPPORT!

BIAColorado.org 303-355-9969

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CO Brain Injury Resources

- CO Department of Education – Exceptional Student Services Unit:
  - Brain Injury in Children & Youth: A Manual for Educators http://www.cde.state.co.us/cdesped/sd-tbi
  - Building Blocks of Brain Development - www.cde.state.co.us/cdesped/sd-tbi_buildingblocks
- Colorado Kids Brain Injury Resource Network: Includes an online, user friendly, clickable version of the Building Blocks of Brain Development with the Assessment component - http://cokidswithbraininjury.com/educators-and-professionals/brain-injury-matrix-guide/
- Article: Neuroeducational Evaluations – The School-Based Answer to Pediatric Neuropsychological Assessments (2017. Crawford, N., Hotchkiss, H., McAvoy, K.)
- Website for Parents and Professionals: www.COKidswithbraininjury.com
- Brain Check Survey: http://www.lobi.chhs.colostate.edu/index.aspx

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Website Resources

- CDE FASD: http://www.cde.state.co.us/cdesped/fasd
- Brain Injury in Youth – Supports for School Success Community of Practice – https://youthbraininjury.obaverse.net/welcome
- LEARNet - A Problem Solving System for Teachers, Clinicians, Parents, and Students (Brain Injury Association of New York State): www.projectlearnet.org
- Brainline & Brainline Kids - http://www.brainline.org/landing_pages/features/blkids.html
- The Center on Brain Injury Research and Training – www.cbirt.org

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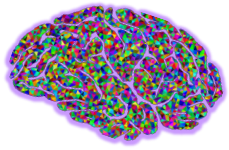

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https://www.cde.state.co.us/cdesped/sd-tbi

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