Traumatic Brain Injury

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Traumatic Brain Injury (TBI)

• A blow or jolt to the head or a penetrating head injury that disrupts brain function (Centers for Disease Control and Prevention) CDC
• Severity of a TBI ranges from
  – mild – diminished or altered state of consciousness or LOC, post traumatic amnesia (PTA) for <24 hrs and a GCS of 13-15 (Kay et al., 1993)
  – Moderate to severe which is longer periods of LOC and PTA following the injury

IDEA’s Definition of “Traumatic Brain Injury”

• Our nation’s special education law, the Individuals with Disabilities Education Act (IDEA) defines traumatic brain injury as...
• “...an acquired injury to the brain caused by an external physical force, resulting in total or partial functional disability or psychosocial impairment, or both, that adversely affects a child’s educational performance. The term applies to open or closed head injuries resulting in impairments in one or more areas, such as cognition; language; memory; attention; reasoning; abstract thinking; judgment; problem-solving; sensory, perceptual, and motor abilities; psycho-social behavior; physical functions; information processing; and speech. The term does not apply to brain injuries that are congenital or degenerative, or to brain injuries induced by birth trauma.” [34 Code of Federal Regulations §300.8(c)]

Primary TBI Age Groups

• 0 – 4 years
• 15 – 19 years
• Adults over the age of 65
• Just over half emergency room visits annually are for 0 – 14 years of age

TBI

• CDC estimates 1.7 million new TBIs annually in the US
• Silent epidemic
  – May result in a lifetime of physical, cognitive, emotional, and behavioral impairments
• Centers of Disease Control (CDC)
  – Estimate 5.3 million Americans live with disabilities associated with TBI

TBI

• 75% of TBIs are concussions or mild TBI (mTBI)
• CDC estimated the cost of TBIs in the US was $76.5 billion in 2000.
Causes of TBI

- MVA 17.3%
- Falls 35.2%
- Firearms 9.7%
- Assaults 10%
- Struck by/Against 16.5%
- Unknown/Other 21%
- CDC

TBI

- Glasco Coma Scale
- Loss of Consciousness
- Post Traumatic Amnesia

Loss of Consciousness (LOC)

- Length of time the person is nonresponsive
- > time of LOC = > severity of TBI
- Patients sometimes may be unaware of the duration of their LOC
- Some TBIs are not witnessed so the person regains consciousness before they are evaluated

Post-Traumatic Amnesia (PTA)

- Time interval from when the person regains consciousness until he or she is able to form memories for ongoing events (Whyte & Rosenthal, 1988)
- During PTA
  - Not fully oriented
  - Not able to remember information after a period of distraction

Severity Grades of TBI

<table>
<thead>
<tr>
<th>Mild (Grade 1)</th>
<th>Moderate (Grade 2)</th>
<th>Severe (Grade 3 &amp; 4)</th>
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</thead>
<tbody>
<tr>
<td>Altered or LOC &lt;30 min</td>
<td>LOC &lt; 6 hours with abnormal CT &amp;/or MRI</td>
<td>LOC &gt; 6 hours with abnormal CT &amp;/or MRI</td>
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<tr>
<td>GCS 13-15</td>
<td>GCS 9-12</td>
<td>GCS &lt;9</td>
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<tr>
<td>PTA ≥ 24 hours</td>
<td>PTA &lt; 7 days</td>
<td>PTA &gt; 7 days</td>
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Mild TBI

- ~80% of TBIs are mild TBI (Alexander, 1995)
  - Studies vary on percent of TBIs that are mTBIs ranging from 75% to 95%
- Injury triggers
  - Pathologic neurochemical cascade
  - Insufficient to produce widespread neuronal dysfunction or axonal disruption characteristic of more severe brain injuries
- Majority of mTBI patients make excellent recovery
- But many have persistent and disabling symptoms
**mTBI: defined by the American Congress of Rehabilitation Medicine (Kay et al., 1993)**

**Diagnostic Criteria for Mild Traumatic Brain Injury**

1. Traumatically induced physiologic disruption of brain function as indicated by at least one of the following:
   A. Any period of LOC
   B. Any loss of memory for events immediately before or after the accident
   C. Any alteration in mental state at the time of the accident
   D. Focal neurologic deficits that may or may not be transient
2. Severity of the injury does not exceed:
   A. Loss of consciousness of <30 min
   B. GCS of 13-15 after 30 min
   C. Post-traumatic amnesia of 24 hr

**Common Pathophysiologies of TBI**

- As a result of Extreme Acceleration and Deceleration
  - Contusions
  - Swelling
  - Diffuse Axonal Injury
  - Broken Blood vessels

**Pathophysiology of Injury**

- Additional Classification of TBI
- Depending on the mechanism of injury and the host response
  - Focal Injury
  - Diffuse Injury
  - Mixed
- *The degree of diffuse injury usually determines the injury grade (mild, moderate, severe)*

**Pathophysiology of Injury**

- Focal Damage
  - Contusion or Hematoma
  - Usually the result of direct impact of the brain against the cranium
    - Most often from impact with frontal and temporal bones or the occipital bone
  - Assess by
    - Standard neuroimaging studies
      - CT
      - MRI
Primary Injuries

- Diffuse Axonal Injury (DAI)
- Results from
  - Rotational and acceleration-deceleration forces
- DAI have been observed on histology specimens following mTBI
- Inferred when there are neurological symptoms in the absence of abnormal neuroimaging

Diffuse Axonal Injury

- Delay and change in functional impairments occur over time due to the ongoing process of events in axonal membranes and cytoskeleton
- Pathophysiological changes are observed diffusely throughout the subcortical white matter, corpus callosum, fornix, internal capsules, cerebellum, and brain stem (Adams, Doyle et al., 1989)

Diffuse Axonal Injury

- Common in TBI
- Causes
  - Generalized cognitive slowing
  - Patients complain of (c/o)
  - Generalized slowing in thinking
  - Difficulty getting things done
  - Reduction of number of cognitive operations the brain can engage in at any given time

Sports Concussions

- Blunt injury
  - Mass related to acceleration/deceleration forces
- Isolated injury
- Typically focal injury in adult injury

Course of Recovery

- Recovery is gradual
- Occurs for at least 18 to 36 months
  - Recovers and regenerates
- Most rapid recovery is during the first 6 months with 80 – 85% recovery
- Recovery of axonal injury
  - Damaged neurons may sprout ancillary axons
  - Reestablish disrupted connections
- Axons that did not sustain total disruption
  - Reverse pathophysiology damage
  - Return to function

Course of Recovery

- Evidence from animal studies that purposeful activities may stimulate axonal regeneration
- Experimentally brain-injured rats were placed in an enriched environment with maze-reward systems and games
  - Improved cognitive functions
  - Dissection showed strong growth of neuronal pathways
  - Not observed in plain cages
Hamm et al., 1996; Passineau, 2001
### Course of Recovery: Mild TBI
- Symptoms of mTBI resolve by 3 months for the majority of patients (Rutherford et al., 1989; Levin, Mattos et al., 1987)
- Minority of mTBI patients have a more lengthy recovery and sometimes have impairments for life (Binder, 1997, Rutherford, 1989; Behrens & Jolles, 1992)
- Prevalence of persistent impairments from mTBI varies from 7-8% (Binder, 1997) to 10-20% (Alexander, 1995) to 33% (Kemel et al., 1981)
- Common accepted prevalence is 20% of patients with mTBI will have persistent impairments requiring ongoing medical care.

### Recovery course of cognitive function in moderate to severe TBI
- Highly individualized
- Dependent on
  - Initial distribution of injury
  - Initial degree of injury
    - Damage to brain cell bodies
    - Damage to axons
    - Damage to synapses
    - Numerous cofactors

### What to expect mTBI children
- May not have LOC
- Look at area of damage:
  - Frontal damage may not manifest till later
  - Dorsolateral develop earlier, expressing earlier deficits/faster recovery
- Type of Damage: diffuse vs focal

### What to expect mTBI children
- Their recovery may appear more rapid. Particularly with:
  - motor, sensory, and language function
  - Appear better and may not receive treatment immediately
  - Previously acquired skills and knowledge preserved or recovered quickly
  - This is important, know that the children in your school with a history of TBI, may need you later!!!
    - Test them often, deficits and delays may not manifest till later.

### Common areas of deficit (ASHA Leader, Nov 2, 2010)
- new learning
- recognizing important information
- generalizing information
- storing new information for effective recall
- delayed auditory processing
- worsening academic and social skills throughout adolescence

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Mild TBI (ASHA Leader, July 14, 2009)
- Watch for kids who have had a recent concussion
- Sports/activity related concussion is 3rd leading cause of TBI in children
- Symptoms: immediate memory, clumsiness, confusion, dizziness, vomiting
- Think Second-Impact Syndrome
- Multiple concussions are linked with: poor neurological test performance, learning disabilities, and vulnerability for additional concussions
- Work as a team with parents, coaches, administration, and students about concussion awareness

(Management of Sports Related Concussion in Children and Adolescence. ASHA Leader, July 14, 2009)
Educational Implications

• Memory
  – Difficulty encoding, storing, retrieving new information
  – Trouble learning new curriculum material/social skills
  – Old material may be in tact
  • May not be obvious child is having trouble initially

• Attention/Concentration
  – Difficulty focusing
  – Sustaining attention for long periods of time.
  – Surrounded by other stimuli
  • Difficulty filtering out important information from distractions in the classroom
  • Quickly become overloaded
  – Trouble switching between different types of information

Educational Implications

• Executive Functions
  – Difficulty understanding problems and considering a variety of solutions
  • May consider one solution at a time and use trial and error to find the correct one (typical of young children)
  – Trouble monitoring/evaluating performance in learning situations.
  • Unable to predict outcome of behavior, understand effects on others
  – Impulsivity during class (comments, actions)
  – Task initiation, even if they’re able to carry out task
  – Sequencing steps in a problem, activity
  – Lack of self-awareness
  • Can’t comprehend if they can reach goals
  – Transfer newly learned information from one setting to another

Assessment

• Alertness
• Awareness
• Orientation
• Attention
  – Focused
  – Maintained
  – Selective
  – Alternating
  – Divided
  – Capacity

Assessment

• Language
  – Word Fluency
  – Expressive Language
  – Thought Organization
  – Receptive Language
  – Pragmatics of Communication
  – In what communication environments

Areas to Assess and Monitor (ASHA Nov. 2, 2010)

• Receptive skills: Can the child understand what is said or written?
  – Becomes confused by lots of spoken or written information
  – Needs information repeated
  – Does not follow conversations
  – Recalls instructions inconsistently
  – Has difficulty understanding spoken words
  – Recalls or understands what has been read with difficulty

Areas to Assess and Monitor (ASHA Nov. 2, 2010)

• Expressive skills: Can the child express ideas?
  – Uses limited vocabulary
  – Does not use new vocabulary
  – Uses rude or immature language
  – Retells the same story repeatedly
  – Talks about unrelated topics
  – Talks quickly or non-stop
Cognitive Impairments of Children

- 2 ages for Peaks of TBI
  - 5 years and under
  - 15 to 24 years
- Children and adolescents
  - Brain injury due to
    - Anoxia
    - Hypoxia
    - Brain tumors and associated irradiation treatments
    - Vascular episodes
    - Neurological diseases
    - Frontal lobe impairments that are developmental (cognitive impairments)
      - ADHD
      - Fetal Alcohol Syndrome
      - Sports

Assessment

- Cognition
  - Initiation
  - Inhibition
  - Discrimination
  - Sequencing
  - Categorization
  - Cause & Effect
  - Comparative Thought Processing

Areas to Assess and Monitor (ASHA Nov. 2, 2010)

- Cognitive-communication skills: Can the child produce and use organized language?
  - Has difficulty expressing thoughts
  - Becomes easily sidetracked
  - Rambles in conversation or writing
  - Provides short answers to questions
  - Leaves out details in a response
  - Loses topic focus and drops out of conversations

(Pediatric Traumatic Brain Injury, ASHA Leader. November 2, 2010)
Assessment

- Language (focal injury vs. more delays in language processing and integration with cognition)
  - Focal injury would look for aphasia type impairments
  - Diffuse Axonal Injury
    - Assess for delays and integration to cognition
    - Pragmatics of communication is impaired due to integration impairments to divided attention skills/multitasking
    - Social communication skills
    - Work communication skills
    - Word Fluency
    - Expressive Language
      - Integration of language with cognition
    - Receptive Language
      - Delayed Auditory Processing

- Memory
  - Immediate memory
  - Short term memory
  - Working memory
  - Long term memory
  - Prospective memory
  - Declarative Memory
    - Facts, Word knowledge, Events, Vocabulary
  - Semantic memory
  - Episodic memory
  - Procedural memory
    - Skills, Habits, Priming, Simple Classical Conditioning

- Learning
  - New learning
  - Optimal method of learning
    - Visual
    - Auditory
    - Tactile
  - Determine memory strategies that work

- Internal Strategies
  - Association
  - Imagery
  - Rehearsal
  - Chunking
  - First-Letter Mnemonics
  - Categorization
  - Semantic Elaboration
  - Verbal Labeling

Process of Remembering New Information

- Attend to relevant stimuli
- Register the stimuli
- Effectively store the information
- Retain the information
- Retrieval of the information

Assessment

- Strengths
- Weaknesses
- Skills and abilities
- Adaptability
- Compensatory strategies
Efficacy Research
• Substantial body of research on efficacy of cognitive rehabilitation with adults
• Little research available on efficacy of cognitive rehab with pediatric TBI patients
• High incidence of TBI among children and adolescents has a big impact on schools, families, vocation needs

TBI: Children
• Despite similar causes and pathophysiology of TBI among children as adults
  – Less likely to sustain LOC
  – Children have a more rapid recovery of motor, sensory and language functions than adults
  – Children may look better sooner despite underlying injury or impairment

TBI: Children
• Until recently, belief that a child’s brain has more plasticity or more flexible than adult brain, therefore less susceptible to permanent brain injury, Kennard, 1942. Referred to as the Kennard Principle: if you are going to have a brain injury have it when you are young.

TBI: Children
• Many studies have shown significant impairments following TBI in children
  – some studies indicate that the greatest impairments occur in children
  – Knights et al., 1991; Levin et al., 1993; Brink et al., 1970; Ewing-Cobbs et al., 1994;
  – Taylor & Alden (1997) reported that nonfocal injuries earlier in life had a significant adverse effect on development of cognitive and behavioral function

TBI: Children
• It appears that young children recover very well from focal injury in early development since there is considerable plasticity in surrounding brain tissue as well as homologous regions of the other hemisphere.
• However, with diffuse, widespread or bilateral injury, plasticity of the nervous system does not appear to be available (Kolb, 1995).
• Levin, Benton, and Grossman. (1982) note that there is no substantial evidence to indicate that the immature brain of the young has an advantage for effects of diffuse injury.

TBI: Children
• No evidence to support that continuous brain development following a TBI follows
  – normal development
  – Post injury reorganization or brain structures result in behavioral recovery
  – Finger & Almli (1985)
**TBI: Children vs. Adults**

- Very different pattern of recovery in children since the deficit is superimposed on active developmental processes (Mateer, Kerns, & Evc, 2001)
- Growing into the Deficit: child may appear to have recovered from TBI, but deficits may not be noticed until the child is older when specific cognitive and behavioral skills are normally attained
- Frontal lobes are the last brain region to develop and are responsible for executive functions (i.e., planning, organization, initiation, inhibition, self-monitoring and regulation and mental flexibility)
  - These areas may not develop in adolescents who suffer brain injury earlier in life
  - Academic and social skills become more complex at the same time that these skills should emerge

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**TBI: Need for long-term monitoring of TBI in children**

- Case study of 2 young adults sustained frontal lobe injury before 16 mos. Exhibited
  - Normal neurological exams
  - Average results on neuropsychological tests
  - Residual frontal lobe damage on neuro-imaging
  - History of significant impairment
    - Decision making
    - Behavioral dyscontrol
    - Impaired social functioning
    - Abnormal emotional responding
  Anderson, Damasio, Tranel, & Damasio, 1999

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**TBI: Assessment in Children**

- Deficit (persistent impairment) vs. delay in development from TBI
- Effect onset of skill
  - Delay in onset
  - Order of emergence of skill
  - Rate of skill development
  - Degree of development of a skill
- Assessment of IQ usually looks normal in children immediately after injury
  - Because it is assessment of verbal IQ which is already learned: knowledge of basic meaning of words, basic social reasoning
  - But measures of nonverbal IQ would be more affected: problem solving and speed of processing
  - Impairments of Attention and memory will show failure to keep up with peers over the years fall further behind even on IQ or achievement tests

**IMPORTANT** to test children often and especially during development when there are rapid skill acquisitions to determine interactions between developmental skills and injury effects

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**TBI: Rehab for children**

- **Adults**
  - Cognitive, speech, motor functioning
  - Vocational and family functioning
  - Set up some type of supported or assisted work experience
- **Children**
  - Cognitive, behavioral and social issues
  - hospital-based treatment
  - School environment
  - Family environment

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**TBI: Rehab for Children**

- **School environment**
  - academic, social and behavioral skills
- **Difficulties in all 3 areas are common for children with h/o TBI**
  - Further complications of
    - Feelings of frustration
    - Lower self-esteem
    - Behavioral outbursts
    - Psychosocial difficulty
  - Years of downward problems are difficult to reverse (Ylvisaker, 1998)

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**TBI: Predicting Rehab Outcome in Children**

- **School Environment success**
  - Adequate education of teachers to integrate children with TBI into the classroom
  - Independence in life is related to basic academic and social competencies attained in school
- **Family Environment**
  - Major variable for outcome of children with TBI
  - Rivara et al., 1992 found that preinjury level of child and family functioning to be the best predictors of behavioral outcome 1 year after injury
  - Rivara et al., 1994 found that both academic and cognitive skills were predicted by family functions and severity of injury
  - Taylor et al., 1999 reported strong relationship of TBI outcome in children 6 mos after injury and family functioning prior to the injury. Further study of outcomes following the 1st year were related to preinjury functions, TBI severity, measures of postinjury family environment
TBI: Rehab in Children
- Limited efficacy studies of specific rehabilitation for children with cognitive impairments Review (Mateer, Kerns, Eso, 1996)
- Specialized teaching strategies
- Academic support
- Compensatory devices and strategies
- Retrain underlying cognitive abilities

TBI: Specialized Teaching Strategies for Children
- Need individualized standardized testing
- Supplemented with neuropsychological examinations
- Curricula and instructional plans should be adapted to individual needs
- Glang et al., 1992 recommend Direct Instruction techniques

TBI: Specialized Teaching Strategies for Children
- Direct Instruction
  - Introduction
    - Modeling of new skills or strategies by the teacher
    - Overt labeling of thinking skills for the activity
      - Problem solving, comparative thinking, convergent thinking
  - Guided and independent practice
    - Adequate practice on new skills and concepts
  - Guided Assistance
    - Gradual fading of teacher guidance or reducing number of prompts
  - Cumulative Review
    - Skill is reviewed and practiced so maintained
    - To integrate new skills with previously learned skills or information

TBI: Specialized Teaching Strategies for Children
- Direct Instruction
  - Specifies elements of a lesson
  - Identifies most effective management
  - Determine instructional pace
  - Adequate processing time
  - Require student responses
  - Monitor student responses
  - Feedback to correct and incorrect responses
  For an example of Direct Instruction Lesson Plan see Archer et al., 1989

TBI: Compensatory Devices & Strategies for Children
- Checklists
- Study materials
- Memory books
- Organizational strategies
- Simplify material to be learned

TBI: Specialized Teaching Strategies for Children
- Glang et al., 1992 completed efficacy study on 3 young children using Direct Instruction
  - Each showed improvement using the teaching strategy
- Individual tutoring has also been used and while efficacy study on 1 student did not report improvement of specific tutoring but did show improvement of general studies which was attributed mostly to improved monitoring skills, Crowley & Miles, 1991
TBI: Efficacy of compensatory strategies

• Kerns & Thomson (1998) efficacy case study using memory notebook and extensive daily checklists for a young girl with brain tumor treated with irradiation resulting in extensive brain damage
  – 2 years after training, no improvement of memory skills on neuropsychological testing
  – No improvement of academic skills
  – Functional improvement to turn in homework assignments and complete school work was reported by teachers and counselors

TBI: Compensatory Strategy in Children & Adolescents

• Ylvisaker & Feeney (1998)
  – Establish structure and routine
  – Promote organizers
  – Use visual aids to support daily routines
  – Individualized treatment
  – Provide choices

TBI: Retraining Cognitive Abilities in Children & Adolescents

• Direct retraining of underlying processes of cognitive functions extensive efficacy data in adults very limited in children and adolescents
• Possible effectiveness of direct retraining in older children and adolescents (Thomson, 1995; Thomson & Kerns, 2000)
• Several problems with using Attention Process Training with
  – Use numbers or letters which may not be developed yet in young children
  – Not meaningful to older children and adolescents

TBI: Retraining Cognitive Abilities in Children & Adolescents

• Other programs of direct attention training may be more appropriate with younger children
  – Psychological Software Services Inc.
  – Pay Attention
    • Uses family pictures and familiar items
    • Kerns et al., 1999 showed improvement in students with ADHD who participated in training of Pay Attention program

TBI: Retraining Cognitive Abilities in Children & Adolescents

• Pragmatic programs of communication have also been studied through peer group training,
  – Efficacy data reveals improvements on pre and post-testing using the Rehabilitation Institute of Chicago Rating Scale of Pragmatic Communication Skills & Communication Performance Scale and improvements were noted through clinical observations in natural settings

TBI: younger than 5 years old

• Limited research data
• Family
  – Teach parents about brain injury and its effects
  – Help parents learn where to find out more about brain injury
  – Facilitate connections with local and national support agencies
  – Teach and monitor behavior management strategies
  – Educate parents about advocacy in schools
  – Teach coping techniques for stress and anxiety reduction
  – Refer to formal psychological services
  – Encourage use of respite as needed
Therapy Approaches

- Direct Therapy
  - Software
    - Captain’s Log
    - Brain Train
    - Psychological Software Services Inc.
    - Parrot Software
  - Manuals
    - Clinician developed or modified
- Compensatory Strategies
- External Aids
- Assistive Cognitive Technology (ACT)
- Psychosocial Support

Managing Impairments of Attention

- Attention process training
  - Cognitive exercises that are designed to improve attentional systems and is based on neuropsychological theory
  - Attentional system can be improved by stimulating a specific part of attention
    - Focused
    - Maintained
    - Selective
    - Alternating
    - divided

Attention Therapy Tasks

- Sustained Attention
  - Listening for target
    - Words
    - Sequences
    - Sounds
    - Pressing a buzzer to respond
  - Paragraph listening for comprehension
  - Phrase and sentence completion tasks
  - Completing math problems
  - Sequencing auditory presented number series in ascending or descending order

- Selective Attention
  - Any sustained attention task with distraction, auditory or visual (from minimal to complex distraction)
  - Cancellation activities
    - Numbers
    - letters

- Alternating Attention
  - Switching activity: listen for one specific item and then requested to switch to another specific item to identify
  - Paper and pencil tasks that require alternating between generating numbers or letters that come before or after a target in a number or letter sequence

- Divided Attention
  - Any 2 tasks at the same time
  - Reading for comprehension while scanning and counting for a specific word
  - Blocks and math problems
  - Blocks, math, and word lists (added memory task)
  - Blocks, math, and clues (added memory task)
  - Complete a sustained attention task while simultaneously performing a reaction time computer task
Attention Therapy Tasks

- Combine tasks for more complex integration between attention tasks, cognitive activities and temporary memory activity

Attention Therapy Tasks

- Practice
  - Phrase completion
  - Confrontation naming
  - Blocks and math
  - Blocks, math, word lists
  - Blocks, math, clues

Attention Therapy Principles

- Treatment should be grounded in attention theory
- Activities should be hierarchically organized
- Provide repetition
- Treatments should be based on patient performance data
- Facilitate generalization from the beginning of therapy

Attention Treatment Efficacy

- Effects of Attention Training
  - Training task itself
  - Psychometric tests that relate to the tasks
  - Everyday functioning

Attention Treatment Efficacy

- Effects of Attention Training
  - Psychometric tests that relate to the tasks
  - Studies showing improvement on unpracticed psychometric tests has been mixed
  - Some studies showed significant improvement following APT
  - Malec et al., 1984 study measured no improvement on psychometric testing following APT but they had a short training period and a limited number of training tasks
  - Ponsford and Kinsella (1988) showed improvement on attention tasks with severe head injury but not anymore than spontaneous recovery

Ben-Yishay, Piackett, & Rattck, 1987
Wood & Fussey, 1987

Diller et al., 1974; Gery, Robertson, Pentland, & Anderson, 1992; Ruff et al., 1989; Sohberg & Mateer, 1987; Sturm et al., 1997)
Attention Treatment Efficacy

- Effects of Attention Training
  - Everyday functioning
    - Improvement for everyday functioning has also been demonstrated by numerous studies
    - Sivak, Hill and Olson (1984) improved driving performance
    - Mateer & Sohlberg, 1988; Mateer, Sohlberg, & Youngman, 1990; Mateer, 1992 showed improvement on measures of attention, memory, learning and independent living and return to work
    - Sohlberg et al., 2000 compared APT to brain injury education measured on tasks of daily life and performance on vigilance, orienting and executive function
    - 14 subjects with TBI; 10 weeks training of each treatment
    - Brain Injury Education was most effective improving self reports of psychosocial function and has some effect for cognitive function when followed APT
    - APT had some improvement of measures of executive attention and working memory
    - Study suggests that APT may be effective for improving types of executive attention and working memory in patients with specific attention problems

Attention Training

- Summary
  - Most studies report effectiveness with attention training
  - Still need to determine which students will benefit most from attention training, specific attention profiles
  - Still need to determine how much improvement can be expected with attention training

Attention Strategies

- Attention Strategies are mostly self-instructional to help a person focus attention on a task
- Tasks that were automatic before TBI now require effort to concentrate

Attention Strategies

- Orienting Procedures
- Pacing
- Key Ideas Log

Attention Strategies

- Orienting Procedures
  - Designed for
    - Specific tasks or environments
      - Reading Routine (when impaired sustained attention for reading)
        1. Preview Subheadings
        2. Recite Subheadings
        3. Ask Questions
        4. Read for Details
        5. Reread Subheadings
        6. Rehearsing

Attention Strategies

- Key Ideas Log
  - Impairments of alternating attention
  - Write down or tape record ideas or questions when they come to mind when working on a different task so the person is not interrupted
  - Write down or tape record where you stop on a task when need to focus on a different task
Attention Strategies

• Environmental Management
  – Task management strategies
    • List what tasks are affected by attention impairment
  – Distractions
    – Difficult vs. helpful environments
    – Noisy vs. quiet restaurants
    – Large stores vs. smaller stores
  – Environmental Modifications
    • Organizing physical space
      – Filing systems, messaging centers, bill payment systems, labeling cupboards
    • Reducing clutter and visual distractions
    • Posting directions for others
      – Do not disturb signs for uninterrupted time at work

Handout: Attention Strategies

1. Reduce Distractions
   – Turn off radios, TVs, etc. when concentrating or having a conversation
   – Use earplugs
   – Close curtains so you are not tempted to stare out the window
   – De-clutter the environment

2. Avoid crowds
   – Plan ahead: drive, shop during off hours when less people
   – If you are in crowds, don’t demand of yourself to do something complicated

3. Ask for help

4. Manage fatigue
   – As soon as feeling overwhelmed, take a break
   – Be persistent, keep coming back to what you are doing
   – Don’t push so hard you get frustrated
   – Get enough sleep, naps are ok as long as you can sleep at night

5. Avoid interruptions
   – Turn ringer off on your phone, use messaging system
   – Use Do Not Disturb sign

6. Get sufficient exercise
   – Some research says a more efficient body = more efficient brain
   – Regular exercise is good for thinking skills

Managing Impairments of Memory

• Restorative/generalized memory intervention approaches
  – Memory practice drills
  – Mnemonic strategy training
  – Prospective memory training
  – Metamemory training
• Domain-specific memory intervention approaches
  – Mnemonic strategy training for specific information
  – Expanded rehearsal time (spaced retrieval methods)
  – Use of preserved priming (method of vanishing cues)
  – Creating a personal history
• External Aids: Assistive Cognitive Technology (ACT)

Strategies to Use with Persons with Memory Problems

1. Simplify information: clear and concise with information
2. Reduce the amount of information to be remembered
3. Check for understanding
4. Try to help the person link information to existing information, make associations
5. Set up practice routines with distributed practice: better to work at learning a few minutes several times a day than for an hour once a day
6. Organize information that needs to be remembered

Restorative Memory Interventions

• Memory Practice Drills
  – Computer drills
  – Workbooks with memory drills
  – No empirical support that memory practice drills improve memory
    • Instead, reported improvement from practice drills is usually related to attention process training.

Restorative Memory Interventions

• Mnemonic Strategy Training
  – Visual imagery
  – Verbal organization strategies
    • Acronyms
    • Paired associations with target words
  – Semantic elaboration
    • Linking target words with ideas in a story
Restorative Memory Interventions

• Mnemonic Strategy Training
  – Some studies have shown efficacy to support use of visual imagery for some patients
    • Cermak, 1975; Wilson, 1982
  – Other studies have shown no efficacy to support use of visual imagery for other patients
    • Baddeley & Warrington, 1973; Crovitz, Harvey, & Horn, 1979
  – Miller, 1992 showed little benefit for real-life contexts for mnemonics
    • Patients do not maintain or generalize mnemonics beyond therapy setting
      • Cermak, 1975; Crovitz et al., 1979; Miller, 1992

Memory Treatment

• External Aids are most helpful

External Aids

• Written calendar systems with day planners
• Written checklists
• Electronic organizers
  – iPod, iPhone, Androids,
  – COZI application
• Voice-activated message recorders
• Task-specific devices
  – Locker Sticker
  – Notebook with Map from Room to Room of Locker
  – Color Coded Notebooks for each class
• Checklists: Homework, Quiz, Test, Behavioral
• Watch alarms

COZI app

SHARED FAMILY CALENDAR
A centralized family calendar you can manage from your phone for planning. Add an appointment and it syncs with your Cozi account so everyone in the family can see it. Set reminders that are sent by text or email messages so no one misses soccer practice or an important event. Use it for homework, quizzes, tests.

SHARED SHOPPING LISTS
SHARED TO DO LISTS
Create a shared to do list,
Again, homework, home chores,..

FAMILY JOURNAL
Jot down a special moment or something important at school and add a photo, it can be reviewed to help recall events

COLOR CODING IS VERY HELPFUL AS AN ORGANIZATIONAL STRATEGY
Cognitive Therapy

- Bracy’s Psychological Services Inc. computer software focuses on initiation, inhibition, discrimination, scanning, and cause and effect programs
- Practice of initiation/inhibition activities
- Design tasks

Executive Functions

- Integrative cognitive processes determine goal-directed behavior and regulate daily life functions:
  - Ability to formulate goals
  - Initiate behavior
  - Anticipate the consequences of actions
  - Plan and organize behavior by
    - spatial, temporal, topical or logical sequences
  - Monitor and adapt behavior
  Cicerone et al., 2000

Executive Functions

- Starting
- Problem solving, shifting, switching
- Planning and Sequencing
- Summarizing
- Sustained attention
- Self-monitoring
- Inhibition
- Organization
- Multi-tasking

Management of Dysexecutive Symptoms

- Initiation tasks
- Inhibition tasks
- Task persistance
- Organization strategies: sequencing and timing behavior
  - Management of environment (organize space)
  - Task management analysis to break large tasks into smaller components
  - Develop check lists
  - Develop plans with strategy to initiate and execute
  - Time management strategies
- Generative thinking (cognitive flexibility)
- Awareness: self-evaluation and insight

Executive Cognitive Strategy

- Goal Management Training
  1. What am I doing?
  2. Define the main task
  3. List the steps of the task
  4. Do I know the steps for the task?
     - Learn the steps
  5. Execute the task
  6. Am I doing what I planned to do?

Self-Awareness

- Self-regulation skills considered to be the core of executive functions
  Butterfield & Belmont, 1977
- Metacognition (thinking about your thinking) self-awareness, self-monitoring and self-control
  Kennedy & Coelho, 2005
- Aspects of metacognition are used in highly complex behaviors and organized around skill sets (not a single skill)
  - Setting goals
  - Comparing performance with goals (i.e., self-monitoring)
  - Making decisions to change behavior (i.e., self-control; choosing an alternative solution)
  - Executing change in behavior (e.g., implementing alternative solution)
Strategies for Note Taking

- Cornell University
- Divide paper in ⅓ to ⅓ space
- Left side is note taking
  - Learning or understanding
- Right side is for remembering
  - Recall the information on the Left by 1-2 words

Strategies for Note Taking

- Live Scribe Pen
  - Specialized Pen and Paper
    - It records what is being said as well as what written notes are being written at the same time
    - Review the notes to assess the organization, language, completeness, what is missing and when the student stops paying attention.
    - WORK ON ORGANIZATION, LANGUAGE, AND COMPLETENESS
  - Livescribe Pen & Alerting Device (used as altering device with a message that goes off at specific time to get back to taking notes)

Bubble Paper Organization

Classroom Strategies

- Teacher can:
  - Provide consistent room arrangement, materials, routines
  - Assign peer to aid student when necessary
  - Build in rest periods
  - Use adaptive materials when necessary
  - Books for home and books for school
  - Seat child next to desk, away from distractions
  - Provide graphics for child to use for problem solving (flow charts, etc)
  - Provide a notebook for each subject

Classroom Strategies

- Child can:
  - Have child use markers to limit the amount of written information on page
  - Use index cards to assist scanning/maintaining her place
  - Use a map, written schedule
  - Leave class early to avoid hallway confusion/traffic
  - Use a tape recorder
  - Provide student with options when given a choice
  - Use color coding/underlining

Teacher’s Role cont.

- Provide accommodations within the classroom
  - Have consistent routines and rules
  - Keep distractions to a minimum
    - Seat child away from windows, doors, etc
  - Allow child additional time to process information
  - Not only for tests, but when answering questions during the lesson
  - Break down complicated instructions to simple one-step directions
  - Repeat directions as necessary
  - Avoid tasks that require the child to concentrate for long periods of time
- Be easily accessible for the child and their parents
  - Let child tell you when they’re receiving too much information, need repetition
  - Have a solid working relationship with parents in order to know their expectations, concerns, etc.


School’s Responsibilities

- Early/ongoing communication with hospitals and rehab centers
- Planning for coordination of services
- Preparing the student, the family, the staff, and peers for a student’s return to school
- Interdisciplinary team participation including an active involvement of the student’s family
- Consideration of the full range of placements, supports, and services in general or special education
- Program modifications, supports, and adaptations
- Flexibility in program planning and delivery of services
- Agreed-upon reentry priorities for academic, social, emotional, and physical needs

SLP’s Role in the School

- Educating teachers and coaches about TBI
  - Conducting an inservice, especially just before a student with a TBI re-enters the school
- Conduct annual evaluations of students who have had a TBI
  - Keep a list of who has had a TBI, even if not recent
  - Call parents annually to determine if there have been any changes in social behavior
  - Provide the Cognitive-Communicative Checklist to teachers and parents
- Possibly conduct evaluations of athletes to assess for TBI

Resources

- Brain Injury Association of Indiana
  - www.biausa.org/Indiana/
  - Educational training modules for school personnel
  - Providing assistance while in the hospital
    - Collaborate with medical facility to determine program and services needed
    - Participate in assessment process and share information
    - Checklist for transition to school
- Considerations when writing an IEP
  - Stages of recovery (early, middle, late)
  - Physical/Health, Communication, Cognitive, Sensory/Perceptual, Motor, Psychosocial

Resources cont.

- Sarah Jane Brain Foundation
  - www.thebrainproject.org
  - Links to state associations
  - Zackery Lystedt Brain Project focuses on sports-related injuries in children
  - The PABI Plan

Sports TBI

- A new law in Indiana requires student athletes to be removed from athletic activities if it is suspected they have sustained a head injury. To return to play, injured athletes must be evaluated and cleared by a health care provider trained in head injury assessment.
List of Symptoms Reported in Athletes After Sustaining a Sports Related Concussion

<table>
<thead>
<tr>
<th>Signs of Concussion</th>
<th>Symptoms of Concussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOC</td>
<td>Dizziness</td>
</tr>
<tr>
<td>Amnesia, retrograde or antegrade</td>
<td>Nausea or vomiting</td>
</tr>
<tr>
<td>Disorientation</td>
<td>Difficulty balancing</td>
</tr>
<tr>
<td>Appearing dazed</td>
<td>Vision changes</td>
</tr>
<tr>
<td>Acting confused</td>
<td>Photophobia</td>
</tr>
<tr>
<td>Forgetting game rules or play assignments</td>
<td>Phonophobia</td>
</tr>
<tr>
<td>Inability to recall score or opponent</td>
<td>Feeling out of it</td>
</tr>
<tr>
<td>Inappropriate emotionality</td>
<td>Difficulty concentrating</td>
</tr>
<tr>
<td>Poor physical coordination</td>
<td>Tinnitus</td>
</tr>
<tr>
<td>Imbalance</td>
<td>Drowsiness</td>
</tr>
<tr>
<td>Seizure</td>
<td>Sadness</td>
</tr>
<tr>
<td>Slow verbal responses</td>
<td>Photophobia</td>
</tr>
<tr>
<td>Personality changes</td>
<td>Hallucinations</td>
</tr>
</tbody>
</table>


Relationship Between Concussion and Neuropsychological Performance in College Football Players

Collins et al. (1999)

- Collins et al. (1999) studied the relationship between concussions and neuropsychological performance in college football players.
- Looked at risk factors, short-term, and long-term outcomes associated with concussions in football players.
- Aims of the study:
  1. Investigate if a relationship exists between prior concussion and diagnosed learning disabled college football players and to determine the influence of the variables, in combination and isolation, on neuropsychological performance.
  2. To evaluate the use of neuropsychological tests in diagnosing and prediction of post concussion recovery.


Methods

- After a player sustained a concussion measures were taken again within 24 hours and at days 3, 5, and 7.
- Controls were also tested within the same time frame to control for exertion.

Results: Long-Term Effects

- Athletes with a Hx of multiple concussions and LD performed significantly worse on neuropsychological measures (executive functioning and speed of information processing) than athletes with no Hx of LD and experienced multiple concussions.
- Hx of 2 or more concussions resulted in long term deficits in:
  - Executive Functioning
  - Speed of information processing
  - Increased self reported symptoms

Education

- 43% of athletes feel that they have some knowledge in the area of SRC.
- Fewer than 50% of athletes understand the problems that occur as a result of concussion.
- Most of them do not consider it to be a serious problem.
- Many athletes who sustain an SRC fail to recognize their symptoms as being a result of concussion.
- A recent survey of coaches revealed that 42% believed that an SRC only occurs when an athlete experiences LOC and 1 in 4 of them would allow an athlete to return to play despite showing symptoms of a concussion.
- Education of athletes, coaches, and medical personnel may lead to increased reporting and proper management.


Methods

- Participants: 393 male college football players.
- Baseline Measures:
  1. Self Reported Data
  2. Educational records were viewed to determine if the participant was diagnosed with a learning disability (LD)
  3. Hx of concussion form was filled out
  4. Battery of neuropsychological tests used by the NFL (30 minutes)
     - Hopkins Verbal Learning Test (verbal learning, delayed memory)
     - Trial Making Tests, Forms A and B (visual scanning and executive functioning)
     - Digit Span Test (attention and concentration)
     - Symbol Digit Modalities Tests (information processing speed)
     - Grooved Pegboard Test dominant and nondominant hand (bilaterial fine motor speed)
     - Controlled Oral Word Association Test (word fluency)
Neuropsychological Impairment in Amateur Soccer Players
Matser et al. (2011)

- Health
- Investigated amateur soccer players and at risk for chronic traumatic brain injury (CTBI)
- Methods
  - All participants were screened
  - Participants interviewed about previous concussions
  - Participants underwent neurocognitive and neuropsychological tests administered
  - Neuropsychological tests administered:
    1. Raven Matrices
    2. Wisconsin Card Sorting Test
    3. Benton Visual Retention Test
    4. Digit Span Subtest of the Wechsler Memory Scale
    5. Trail Making Test
    6. Stroop Test
    7. Bourdon Card Task
    8. Complex Figures
    9. Verbal Fluency Test
    10. 15-Minute Memory Test
    11. Benton Facial Recognition Test
    12. Figure Detection Test
    13. Similar Figure Test
    14. Puncture Test

Assessments of Sports TBI

Results

- Amateur soccer players showed impairments in planning and memory.
- Amateur soccer may be associated with mild CTBI.
- Concussions that are obtained in amateur soccer my play a role in the development of cognitive impairment.

SAC: Standardized Assessment of Concussion

- Purpose:
  - Objective & standardized measurement used to immediately assess injured athlete's mental status (sideline assessment)
  - Not meant to be a stand-alone measure
  - Ex. athlete should also have neuropsychological evaluation and postural stability testing when appropriate
- McCrea, 2005: “a drop of 1 point or more from preseason baseline score on the SAC, was 95% sensitive and 76% specific in correctly classifying injured and uninjured subjects”
  - Results indicate significant neurocognitive changes can be detected on standardized test even in absence of LOC/PTA/focal neurological abnormalities
  - (Review: sensitivity is the % of athletes with TBI correctly identified as having a TBI, specificity is the % of non-injured athletes correctly identified as non-injured)

SAC

- Positives:
  - Free
  - Fast administration
  - Objective & standardized
  - High sensitivity (95%) and specificity (76%)
- Negatives:
  - Seems possible to “cheat” (it’s on-line)
  - Does not assess all cognitive domains (e.g. reaction time & processing speed)
  - Need more data to determine how long an athlete should be withheld from playing after concussion
King-Devick Test

3----7---1---4--2---9
4---2-3---8---1---7
8----7---1---9---8---1
0---6---1---8---2---5

3 different “styles” of cards; sum of time to read each card error-free is score

ImPACT Test

• Positives:
  – Objective
  – Sideline screening
  – Reasonable cost for small teams/families:
    • Family: $45/yr
    • Team: $150/yr - $1,000/yr

• Negatives:
  – Limited areas of assessment (does not assess immediate/delayed recall, etc)
  – Website does not discuss possibility of using this tool to determine athlete’s ability to return to play

ImPACT: Immediate Post-Concussion Assessment and Cognitive Testing

• Purpose:
  – Objective, “computerized neurocognitive assessment tools and services” to be used by doctors, trainers, etc. to assess athletes and determine ability to return to play following a concussion
  – Test time: 20 minutes
  – Some NFL teams are implementing this test
  – Purdue study (on Jefferson H5 football players):
    – Two groups: concussion with symptoms and no concussion without symptoms
    – Third group emerged: no diagnosis of concussion, but sustained hit(s) with enough force to result in neurocognitive changes (ImPACT) and neurophysiologic changes (from fMRI)
  
• http://www.impacttest.com/

ImPACT

• Positives:
  – Near infinite number of alternative forms (minimizes practice effects)
  – Objective measure to help determine ability to return to play
  – Electronically saves player’s data
  – Group administration (one athlete/computer)
  – More in-depth assessment than other two tests

• Negatives:
  – Need a computer (not realistic for sideline administration)
  – Cost is $500-1,000 for academic institutions (HS, colleges, universities)
  – Cost is $750-3,000 for clinics, doctors offices, and sports medicine centers

• About 2/3 of Indiana Schools are using the ImPact testing system.

• Assesses:
  – Attention span
  – Working memory
  – Sustained and selective attention time
  – Response variability
  – Non-verbal problem solving
  – Reaction time

• Description of each subtest available at: http://impacttest.com/index.php/about/test_features/neurocognitive_test
Return-to-play

Management: Return-to-play

- Still trying to establish evidentiary based guidelines
- Changed when grading system changed (which emphasized LOC and amnesia) and were not beneficial in predicting the severity or duration of concussion
- Each concussion should be managed individually by using multiple assessments.
- Proposed guidelines include:
  - Complete resolution of symptoms at rest and during exercise.
  - More conservative return-to-play decisions should be considered for younger athletes because they require longer recovery time.
- Studies reveal concussed athletes score poorly on neuropsychological tests when compared with their own pre-injury baseline scores and with uninjured athletes (Hence baseline pre-injury evaluation)

http://nflhealthandsafety.com/commitment/regulations/

Computerized neuropsychological testing

- Using computerized neuropsychological testing because it is more sensitive to diagnosing concussion
- Lower score than that of a player’s baseline signifies incomplete recovery.
- Incomplete recovery can alter an athlete’s reaction time, ability to concentrate, and thought processing time which increasing the risk of subsequent injury.
- However, safety of returning an athlete to play on the basis of neuropsychological testing has not been explicitly studied.
- But... given the association between returning to play before complete recovery and poor outcomes, it is recommended that return-to-play decisions be based on results of neuropsychological testing

NFL and brain injuries

- First meeting of Mackey White Traumatic Brain Injury Committee in January 2010
- The group was named in honor of two Hall of Fame players – tight end John Mackey who has been diagnosed with Alzheimer’s disease, and defendant Reggie White who died at 43 after retiring from the NFL.
- Dr. Thom Mayer, medical director of the NFL Players’ Union, is serving as the committee chairman.
- The committee is leading medical and neurological experts to advocate for health, safety, and education of NFL players, to interpret science that supports research and progressive changes in the game to protect players.
- Advocates for proper diagnosis and treatment of head injuries, as well as increased awareness and education

http://m.nflplayers.com/Articles/Public-News/TBI-Committee-Continues-Work-Changing-Culture-in-Football/

Change in grading system

- At the 2nd International Conference on Concussion in Sport, traditional grading systems were abandoned for classifying concussions as simple or complex.
- Simple concussion resolves in 7 to 10 days.
- Complex concussion occurs when the athlete’s symptoms persist, the athlete has sustained multiple concussions, or the athlete suffers sequelae such as convulsions, LOC of 1 minute, or prolonged cognitive impairment.
- Under this new classification system, a concussion cannot be classified until all the signs and symptoms have resolved because the signs and symptoms of concussion can have delayed onset (up to several days after the time of onset)


Return to play protocol: Recommended by the 2nd International Conference on Concussion in Sport

<table>
<thead>
<tr>
<th>Step</th>
<th>Level of Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No activity, complete rest; proceed to level 2 once symptoms resolve</td>
</tr>
<tr>
<td>2</td>
<td>Light aerobic exercise (eg, walking, stationary cycling)</td>
</tr>
<tr>
<td>3</td>
<td>Sport-specific exercise (eg, skating in hockey, running in soccer); addition of light resistance training</td>
</tr>
<tr>
<td>4</td>
<td>Noncontact training drills; progressively increased resistance training</td>
</tr>
<tr>
<td>5</td>
<td>Full-contact training after medical clearance</td>
</tr>
<tr>
<td>6</td>
<td>Game play</td>
</tr>
</tbody>
</table>

NFL, brain injuries, and return to play guidelines

• 2009 stricter statements on return-to-play for a player who sustains a concussion developed by the NFL’s medical committee on concussions in conjunction with team doctors, outside medical experts, and the NFL Players Association

• “Once removed for the duration of a practice or game, the player should not be considered for return-to-football activities until he is fully asymptomatic, both at rest and after exertion, has a normal neurological examination, normal neuropsychological testing, and has been cleared to return by both his team physician(s) and the independent neurological consultant. Players are to be encouraged to be candid with team medical staffs and fully disclose any signs or symptoms that may be associated with a concussion.”

http://nflhealthandsafety.com/commitment/regulations/

The Information Following is for your reference. We will not be reviewing this information during the program so you don’t need to print it.

Neuroanatomy and Common Deficits Associated with Site of Injury

Frontal Lobes

• Frontal lobes are susceptible to injury
• Anterior portion of frontal lobes
  – Essential to higher cortical functioning
    • Executive functions
      – Integrative functions
      – Ability to focus attention to appropriate stimuli
      – Organize and plan
      – Problem-solve
      – Formulate good decisions
      – Exhibit appropriate judgment
    – Behavioral Control and emotion and ability to empathize with others

Frontal Lobes: Anterior Damage

• Impairments
  – Planning
  – Carrying out activities that used to be completed with little effort (homework, sports plays, completing household chores)
  – More concrete thinking vs. abstract thinking
  – Decreased mental flexibility
  – Difficulty staying on tasks
  – Difficulty completing activities

Frontal Lobes: Anterior Damage

• Behavioral impairments may be paradoxical causing either/or
  – Increased in disinhibition and immaturity
  – Decrease in energy, motivation and spontaneity
Fontal Lobes: Posterior Damage

- Posterior area contains the motor strip
- Damage in this area can result in reduced abilities
  - To carry out motor tasks
  - Actual hemiparesis or hemiplegia
  - Associated with spasticity

Frontal Lobes: Anterior to Motor Strip-Sylvian Fissure

- Broca’s aphasia
  - Nonfluent speech
  - Agrammatic speech
  - Consists mostly of nouns and verbs

Temporal Lobes

- Highly susceptible to injury
- Integral to memory function
- Play a role in modulating behavior
- Damage especially to hippocampal area
  - Difficulty storing new memories
  - Old memories are preserved

Temporal Lobes

- Right Temporal Lobe
  - Visual memory
- Left Temporal Lobe
  - Verbal memory
  - Language function and can impair
    - Word-finding or naming, anomic aphasia
- Behavioral Problems
  - Increased irritability
  - Increased aggression

Parietal Lobes

- Instrumental for processing sensory information
- Right Parietal Lobe
  - Processes visual-spatial information
  - Get lost in familiar and unfamiliar areas
- Left Parietal Lobe
  - Language function
  - Impairment to understand written and spoken language

Occipital Lobes

- Reception and processing of visual information
- Damage resulting in visual deficits
  - Visual field cuts
  - Inability to recognize known objects
  - Blindness
Cerebellum

- Major role in coordinated movement
- Damage results in
  - Ataxia
  - Impaired coordination for walking
  - Impaired coordination for use of upper extremities
  - Ataxic speech (type of dysarthria)
- Nystagmus
- Tremors


