Bridging the Gap for Pediatric Patients with mTBI as They Return to School.

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Learning Objectives

- Participants will describe common deficits experienced by children/adolescents with mTBI.
- Participants will name areas of cognitive communication and how they relate to language.
- Participants will describe how these deficits may negatively affect participation in school.
- Participants will identify appropriate assessment measures to support children/adolescents with mTBI.
- Participants will describe appropriate evidenced-based accommodations and treatment strategies to support children/adolescents with mTBI upon return to school.

BACKGROUND

More about Traumatic Brain Injury

Traumatic Brain Injury

- A Traumatic Brain Injury (TBI) is an injury to the brain that impacts the way it functions. Brain injuries are classified into two categories: Closed brain injury and penetrating brain injuries.
- Injuries may be caused by a bump/blow to the brain or a penetrating injury to the brain.
- Three classifications: Mild TBI (mTBI), Moderate TBI, Severe TBI
- Causes: Motor vehicle accidents, falls, firearms, assaults, sports related injuries (e.g. concussions), etc.

(Centers for Disease Control and Prevention, 2021)

TBI Statistics

- United States: 1.5 million annually
- 75% classified as mild
- Most patients will spontaneously recover; however some will present with ongoing symptoms that negatively impact daily cognitive functions.

(Permenter et al., Jan 2022)

Hospitalizations due to Brain Injuries

According to the CDC:

- Hospitalizations: 223,050 in 2018
  - 16,480 of these hospitalizations were pediatric patients (birth to 17 years)
- Deaths: 60,611 in 2019
  - 2,476 of these deaths were in pediatric patients
- Data doesn't include ER, primary care, or urgent care visits.

(Centers for Disease Control and Prevention, 2021)

Glasgow Coma Scale

- Tool used to communicate the level of consciousness of patients who have had an acute brain injury.
- Described by Bryan Jennett and Graham Teasdale (Assessment of coma and impaired consciousness. A practical scale. Lancet 1974; 2:81-4.)
- Scale looks at Eye Opening, Verbal Response, and Motor Movements.
- Used in 80 countries and has been translated into multiple languages.

(Royal College of Physicians and Surgeons of Glasgow, n.d.)

TBI Severity

- Mild TBI (mTBI): Also known as a concussion
- The patient may or may not lose consciousness
- Alteration of consciousness may range from a moment up to 24 hours
- The patient may present with Post-Traumatic Amnesia (PTC) from 0-1 days
- Glasgow Coma Scale (best available within first 24 hours): 13-15

- Moderate TBI
- Marked by loss of consciousness <24 hours in length
- Neurological signs of injury (e.g. Skull fractures)
- The patient may present with Post-Traumatic Amnesia (PTC) from >1 day up tp <7 days
- Glasgow Coma Scale (best available within first 24 hours): 9-12

- Severe TBI
- Marked by loss of consciousness >24 hours in length
- Neurological signs of injury
- The patient may present with Post-Traumatic Amnesia (PTC) >7 days in length
- Glasgow Coma Scale (best available within first 24 hours): <9

(O'Neil et al., 2013)

Non-Traumatic Brain Injury

- This type of injury is due to damage to the brain caused by internal factors. This can be caused by toxin exposure, tumors, lack of oxygen to the brain.
- Causes: Brain tumor, stroke, heart attack, near-drowning, infection, aneurysm, etc.

(Brain Injury Association of America, n.d.)

Symptoms of TBI

Speech-Language Specific Signs and Symptoms of TBI

- Cognitive
- Language
- Physical
- Sensory –Perceptual
- Dysphagia
- Neurobehavioral
- Voice
- Speech

(American Speech-Language-Hearing Association, n.d.)

Post Injury Symptoms

- Permenter et al. (2022): Approximately 90% of symptoms typically resolve within 10-14 days. Persistent postconcussive syndrome is diagnosed when symptoms last more than 3 months.
- Zemer et al. (2016): Found that 31.0% children (median age 12) had persistent symptoms at 28 days post.
- According to the DSM IV, to diagnose, the patient must present with cognitive deficits (attention and/or memory) in addition to a minimum of 3 symptoms from the list below:
  - Symptoms:
    - Headache
    - Dizziness
    - Sleep Disturbance
    - Fatigue
    - Irritability
    - Personality changes
    - Affective disturbance

(Permenter et al., 2022)
(Zemer et al., 2016)

Additional Symptoms

- Anxiety
- Impaired concentration
- Memory deficits
- Vision issues
- Tinnitus
- Sensitivity to light & noise
- Changes in sense of smell & taste (Rarely)

(Mayo Clinic, 2020.)

Risk Factors for Persistent Symptoms

Risk factors that may affect recovery include:

- History of concussions
- Comorbid diagnoses
- Gender
  - Females are more likely to experience post-concussion symptoms
- Presence of headaches/migraines
- Type of sport, if sports based
- Age
  - Younger children may have prolonged recovery periods

(Scopaz & Hatzenbuehler, 2013)

What are Cognitive Communication Impairments?

A cognitive communication disorder is any difficulty in cognitive function that makes it more difficult for the individual to talk, understand, and/or learn new information.

It includes:

- Orientation
- Memory
- Attention
- Reasoning/Problem Solving
- Executive Function

(American Speech-Language-Hearing Association, n.d.)

Orientation

- Person
- Location/Place
- Time
- Situation

Memory

- **Immediate→Short Term Memory.** Memory of new information for up to a couple of minutes.[A]
- **Long Term Memory.** Memory of information for longer periods of time (longer than a couple of minutes).[B]
- **Episodic Memory.** Memory of events or facts from the person's life.[B]
- **Semantic Memory.** Memory of objects/characteristics; general knowledge of the world.[B]
- **Procedural Memory.** Memory of how to complete tasks.[B]
- **Working Memory.** Ability to remember information and think about it or manipulate the information at the same time.[B]
- **Prospective Memory.** Ability to plan ahead and remember things the person has to do in the future.[A]

A. (American Speech-Language-Hearing Association, n.d.)

B. (ADT Group, n.d.)

Attention Tasks

https://www.youtube.com/watch?v=vJG698U2Mvo

Selective Attention Test from Simons & Chabris (1999)

(Simons, 2010)

Attention

- **Sustained Attention.** Ability to stay focused on one task for a longer amount of time.
- **Selective Attention.** Ability to stay focused on one task even when there are distractions or other stimulation in the background.
- **Alternating Attention.** Ability to switch attention back and forth between different tasks.
- **Divided Attention.** Multi-tasking. Ability to respond and participate in multiple different tasks at the same time.
  - Happens often in a classroom environment.

(NeuronUp, n.d.)

STROOP Test

https://faculty.washington.edu/chudler/java/ready.html

Executive Function

Combination of skills to manage day to day tasks including planning ahead, initiating and finishing tasks, being flexible when things do not go as planned, and solving problems accordingly. It also includes:

- **Inhibition.** Being able to stop or prevent impulses to say, do, or think about information that is not immediately relevant.
- **Time Management.** The ability to plan how long a task may take and how to account for potential issues that may arise.
- **Self Awareness.** The awareness of someone's own weaknesses and ability to identify ways to improve.
- **Awareness of Others.** The person needs to be able to recognize when others do not understand them, learn to work together with others, and resolve difficulties in a way that meets the needs of the group.
- **Working Memory.** Described earlier.
- **Metacognition/Reasoning Skills.** Next slide.

(American Speech-Language-Hearing Association, n.d.)

Problem Solving & Reasoning Skills

This includes the person's ability to:

- Know that there is a problem
- Name the problem
- Think of possible solutions to the problem
- Determine the best solution
- Take action to solve the problem
- Follow up to make sure the solution has worked and change it, if needed

(Model Systems Knowledge Translation Center, 2020)

Thinking About School

Impact on school success

- Language processing in a fast paced learning environment
- Impaired reasoning and problem solving skills can lead to social issues and organization of daily demands
- Difficulty integrating and then storing newly learned information
- Impaired discourse functioning
- Increase risk of symptoms and cyclical course

(Hall, et al., 2021)

Research

- Qualitative ethnographic study
- October 2018 - October 2019
- Students between ages of 14-16
- Returned to school post concussion

(Wan et al., 2021)

What did the participants have to say?

Results indicated that the participants felt:

- Misunderstood
- Overwhelmed
- Accommodations lacked consistency, clarity, and implementation
- Challenges with returning to school when memory deficits persist
- IEP/504 Plan follow thru lacking
- Finding balance

(Wan et al., 2021)

How can accommodations support return to school efforts?

- Study found that appropriate support = more straightforward recovery.

(Wan et al., 2021)

Medical Interventions

Hospital Based Supports, Outpatient Follow Up

- Concussion Clinics:
  - Multidisciplinary approach which may include the following disciplines: MD, NP, SLP, OT, PT, RN, Neurology/Neurosurgery, Psychology.
- Primary Care Physician:
  - Assessment and treatment

(Pleacher & Dexter, 2006)

Medical Interventions after mTBI

Recent literature no longer supports complete "Cognitive rest" or "brain rest"

Article	Strict Rest	Aerobic Exercise or Routines
Thomas et al. (2015)	X	✓
Grool et al. (2016)	X	✓
Willer et al. (2019)	X	✓
Leddy et al. (2021)	X	✓

Screen Time

Most advocating for limited screen time in initial stages.
-Consider effects on sleep, vision, headaches/migraines.

Macnow et al. (2021) article compared different screen time uses; however, ongoing discussion needed for outstanding factors.

Return to School

Balance of too little vs. too much

CIF Concussion Return to Learn (RTL) Protocol

Instructions:

- Keep brain activity below the level that causes worsening of symptoms (e.g., headache, tiredness, irritability).
- If symptoms worsen at any stage, stop activity and rest.
- Seek further medical attention if your child continues with symptoms beyond 7 days.
- If appropriate time is allowed to ensure complete brain recovery before returning to mental activity, your child may have a better outcome.
  - Do not try to rush through these stages.
- Please give this form to teachers/school administrators to help them understand your child's recovery.

Stage	Home Activity	School Activity	Physical Activity
Brain Rest/ Restful Home Activity	• Initially sleep as much as needed (allow at least 8-10 hours of sleep) • Allow short naps during day (less than 1 hour at a time) • Move towards setting a regular bedtime/wake up schedule as symptoms improve • Avoid bright light if bothersome • Stay well-hydrated and eat healthy foods/snacks every 3-4 hours • Limit "screen time" (phone, computer, video games) as symptoms tolerate; use large font	• No school • No homework or take-home tests • May begin easy tasks at home (drawing, baking, cooking) • Soft music and 'books on tape' okay • Limit reading of hard-copy books as symptoms tolerate (e.g., short intervals of 10-15 min) • Once your child can complete 60-90 minutes of light mental activity without a worsening of symptoms they may go to the next step	• Walking short distances initially to get around is okay • As symptoms improve, progress physical activity, like vigorous walking • No strenuous exercise or contact sports • No driving
	Progress to the next stage when your child starts to improve, but may still have some symptoms		

(California Interscholastic Federation, 2019)

Return to School - *PARTIAL DAY*	• Set a regular bedtime/wake up schedule • Allow 8-10 hours of sleep per night • Limit napping to allow for full sleep at night • Stay well-hydrated and eat healthy foods/snacks every 3-4 hours • Limit "screen time" and social activities outside of school as symptoms tolerate	• Gradually return to school • Sit in front of class • Start with a few hours/half-day • Take breaks in the nurse's office or a quiet room every 2 hours or as needed • Avoid loud areas (music, band, choir, shop class, locker room, cafeteria, loud hallway and gym) • Use brimmed hat/earplugs as needed • Use preprinted large font (18) class notes • Complete necessary assignments only • Limit homework time • No tests or quizzes • Multiple choice or verbal assignments better than long writing assignments • Tutoring or help as needed • Stop work if symptoms increase	• Progress physical activity and as instructed by physician • No strenuous physical activity or contact sports • No driving
	Progress to the next stage as symptoms continue to improve and your child can complete the activities listed above		
Return to School - *FULL DAY*	• Allow 8-10 hours of sleep per night • Avoid napping • Stay well-hydrated and eat healthy foods/snacks every 3-4 hours • "Screen time" and social activities outside of school as symptoms tolerate	• Progress to attending core classes for full days of school • Add in electives when tolerated • No more than 1 test or quiz per day • Give extra time or untimed homework/tests • Tutoring or help as needed • Stop work if symptoms increase	• Progress physical activity and as instructed by physician • No strenuous physical activity or contact sports • Okay to drive
	Progress to the next stage when your child has returned to full school and is able to complete all assignments/tests without symptoms		
Full Recovery	• Return to normal home and social activities	• Return to normal school schedule and course load	• Start CIF Return to Play Protocol

CIFSTATE.ORG *Revised 02/2019 CIF*

(California Interscholastic Federation, 2019)

Speech-Language Assessments

Speech-Language Pathology Evaluation Beyond Discharge

More formal/informal assessment measures for the following areas:

- Memory
- Attention
- Problem Solving
- Executive Function
- Language and information processing
- Expressive language
- Social Communication
- Verbal fluency
- Conversational discourse

SLP Evaluation Options

- Standardized assessments
- Informal or non-standardized methods
- Behavioral observations
- Child/parent or caregiver self-report measures

Limitations of Standardized Assessments

Need to Consider Eligibility and Standard Deviation Requirement; However…

Research has shown that standardized assessments are not always effective in identifying deficits experienced by individuals with mTBI (Allen et al., 2010; Hall et al., 2021; Turkstra et al., 2015).

Considerations

- Standardized testing is done 1:1, often private location
- Classrooms are full of distractions
- Environment may exacerbate symptoms, which then negatively affects performance
- Fatigue. Class schedule or day may have different demands (sitting for longer durations, focus for longer, or need to switch gears each period)
- Higher level difficulties may not be captured by testing, but may present during homework or self study
- Limits in standardized tests available for pediatric mTBI
- Meta-awareness and self-regulation

Clinical Evaluation of Language Fundamentals-Fourth & Fifth Edition

Ages 5-21;11
Norm referenced, standardized
Variable time

How does these subtests apply to cognitive communication?

Other Standardized Options

Pediatric Traumatic Brain Injury (PTBI)
Ages 6-16
Criterion referenced, standardized
Can be completed in ~30 min
-Orientation, receptive language, attention, verbal/word fluency, vocabulary, verbal expression, immediate and delayed recall of stories, narrative comprehension and recall, visual memory, and organization

Test of Verbal Conceptualization and Fluency (TVCF)
Ages 8-89;0
Norm-referenced, standardized
Can be completed in 25-30 min
-Category naming, letter naming, trail making (Trails-C)

Other Standardized Options

Ross Information Processing Assessment-Primary (RIPA-P)
Ages 5-12;11
Norm-referenced, standardized
Can be completed in ~30 min
-Meant for TBI, areas of cognitive function.

Ross Information Processing Assessment-2 (RIPA-2)
Ages 15-90
Norm-referenced, standardized
Can be completed in ~30 min
-Meant for TBI, areas of cognitive function.

Informal Assessment Measures

Consider process and steps to complete in lieu of content knowledge (Turkstra et al., 2015).

ASHA suggests asking questions like:

- *"Does time pressure affect performance in the classroom?*
- *Can the student prioritize tasks or manage more than one task at a time?*
- *Do classroom accommodations or task modifications help maximize the student's academic performance?*
- *What natural supports in the classroom (e.g., priority seating, partnering with peers) can facilitate academic success for the student?*
- *What social skills should be developed to support successful communication?"*

(American Speech-Language and Hearing Association, n.d.)

Turkstra et al. (2015) revealed areas that are more likely to show deficits including ability to make inferences, "rapid comprehension or production," and social use of language. Executive Function and working memory deficits may be revealed in conversation.

Just a Few Informal Options

Consider daily school work demands: Listening to lessons, reading, forming essays, quizzes/tests, working with peers.

Memory:
- Reading/listening task with need to commit to memory
- Recall vocabulary words or other information across short duration
- Sentence unscramble
- Reorder information alphabetically
- N-back
- Remembering what to do in future

Attention:
- Listening or reading tasks while gradually increasing distractions
- Requiring students to alternate between tasks and/or readings

Executive Function:
- Organize task/day
- Resolve issues that arise
- Create own business
- Effectively use agenda

Language:
- Answer comprehension questions after reading/listening task
- Form narratives in writing and verbally
- Use age appropriate vocabulary
- Name synonyms/antonyms
- Organize essays

Review of Nonstandardized Tasks

Following slides taken from Hall et al. (2021)

Review of articles between January 2000 and August 2019

-Nonstandardized assessment tasks, compared to standardized assessment measures

Table 2. Characteristics of studies included in full review.

Study	Assessment method	Skill(s) targeted	Disciplines involved	Sample size (*N*)	Clinical setting	Country of origin
Discourse analysis						
Chapman et al., 2004	Text genre: narrative; response modality: verbal	Discourse macrolevel processing and verbal expression	SLP and neuropsychology	*N* = 55–23 children with severe TBI (≥ 2 years postonset) vs. 32 controls with TD. Ages 7–14 years.	University department.	USA (Texas)
Lundine et al., 2018	Text genre: expository; response modality: verbal	Discourse macrolevel processing and verbal expression	SLP only	*N* = 55: 5 adolescents with TBI vs. 50 controls with TD. Ages 13–18.	University department, with participants recruited from a local children's hospital.	USA (Ohio)
Moran et al., 2012	Text genre: expository/ persuasion; response modality: verbal	Spoken persuasive discourse and working memory	SLP only	*N* = 16: 8 adolescents with (A)BI vs. 8 matched controls with TD. Ages 11–17 years.	School or home, depending on the participant.	New Zealand and USA (Oregon)
Instrumental activity of daily living (IADL)						
Chevignard et al., 2009	Children's Cooking Task	Executive functioning, specifically multitasking	OT and SLP	*N* = 28: 10 children with moderate-to-severe TBI vs. 18 matched controls with TD. Ages 8–14 years.	Pediatric rehabilitation hospital with a mix of inpatients and outpatients.	France
Chevignard et al., 2010	Children's Cooking Task	Executive functioning, specifically multitasking	OT and SLP	*N* = 46: 25 children with TBI vs. 21 matched controls with TD. Ages 8–20 years.	University department, with participants recruited from local outpatient clinics.	France
Krasny-Pacini et al., 2015	Children's Cooking Task	Prospective memory	OT and SLP	*N* = 87: 54 children with (A)BI vs. 33 controls with TD. Ages 8–20 years.	Not reported.	France
Cook et al., 2008	Birthday Task	Executive functioning, specifically self-regulation	SLP only	*N* = 32: 11 children with severe TBI vs. 21 controls with TD. Ages 8–16 years.	University department.	USA (Texas)
Virtual reality						
Erez et al., 2013	The Four-Item Test in the "Virtual Supermarket"	Executive functioning	OT only	*N* = 40: 20 children with TBI vs. 20 matched controls. Ages 8–16 years.	Children's hospital and university laboratory.	Israel
Gilboa et al., 2015	Sustained attention task in the "Virtual Classroom"	Attention	OT and SLP	*N* = 76: 41 children with (A)BI (TBI or brain tumor) vs. 35 matched controls with TD. Ages 8–16 years.	Not reported.	Israel and France
Hanten et al., 2011	Interpersonal negotiations strategy interview	Social skills, specifically conflict resolution	Neuropsychology, radiology, rehab specialists	*N* = 28: 15 adolescents with moderate-to-severe TBI vs. 13 controls with TD. Ages 12–19 years.	University laboratory with access to neuroimaging equipment.	USA (Texas)

(table continues)

(Hall et al., 2021)

Table 2. *(Continued).*

Study	Assessment method	Skill(s) targeted	Disciplines involved	Sample size (*N*)	Clinical setting	Country of origin
Structured cognitive task						
Dennis et al., 2013	The Literal Truth, Ironic Criticism, and Empathic Praise Task (Dennis et al., 2001)	Social skills, specifically parsing of indirect speech	Neuropsychology	*N* = 128: 71 children in the chronic stage of TBI vs. 57 matched controls with orthopedic injuries (OIs). Ages 8–13 years.	Hospital setting.	Canada (Toronto) and USA (Ohio)
Shanahan et al., 2011	The Party Planning Task	Executive functioning, specifically planning	SLP and OT	2 adolescents with severe TBI. No control group. Ages 16.8 and 18.5 years.	Isolated meeting rooms within a school setting.	Australia
Functional rating scale						
Long et al., 2005	Functional Independence Measure for Children (WeeFIM)	Functional communication and social cognition	OT, PT, SLP	23 patients with (A)BI. No control group. Ages 1;2–5;8.	Pediatric rehabilitation hospital with an in-house educational program.	USA (Virginia)
West et al., 2014	School Function Assessment (SFA)	Participation in school environment	OT, PT, SLP	70 patients with (A)BI (31 TBI, 28 nontraumatic BI, and 10 anoxic BI). No control group. Ages 4–18 years.	Pediatric rehabilitation hospital with an in-house educational program.	UK

Note. SLP = speech-language pathologist; TBI = traumatic brain injury; TD = typically developing; OT = occupational therapist; PT = physical therapist; (A)BI = (acquired) brain injury.

(Hall et al., 2021)

Table 3. Nonstandardized methods of assessment described in included studies.

Study	Procedure	Outcome measures used	Other forms of assessment used	Results
Discourse analysis				
Chapman et al., 2004	Following a brief lesson and guided practice with summarization, participants were asked to verbally summarize a lengthy narrative passage containing a clear moral.	Summaries were broken into T-units and analyzed for reduction and transformation of narrative text information. Degree of reduction was measured by comparing number of T-units in summary to that of the original. Degree of transformation was evaluated using a 0- to 9-point rating scale.	Block Design and Vocabulary subtests of the WASI; CLVT-C; Formulated Sentences subtest of the CELF-4.	Compared to controls, the TBI group produced equally reduced but less transformed information in their summaries. Children who were > 8 at injury were significantly more capable of transforming information than those who were < 8 at injury. Summarization ability was significantly related to problem solving, but not to lexical or sentence-level language skills or memory.
Lundine et al., 2018	Following a brief lesson and guided practice with summarization, participants were asked to verbally summarize 2 expository video lectures (1 compare-contrast and 1 cause-effect).	Summaries were segmented into C-units and analyzed using a holistic scoring rubric. Summaries were assigned macro- and microstructural composite scores as well as total quality scores.	5 subtests from the NIH Toolbox Cognition Battery; Recalling Sentences subtest of the CELF-5.	Mean summary quality scores for both exposition types were at least 1 *SD* lower for TBI compared to TD and 2 *SD*s below for the cause-effect passage. The majority of adolescents with TD showed the opposite pattern: Performance on the cause-effect passage was better than the compare-contrast. Scores on discourse analysis were not significantly related to expressive syntax scores.
Moran et al., 2012	After viewing a narrated photomontage that presented both sides of the issue, participants stated whether they thought team sports or individual sports were better and to provide reasons to support their claim.	Spoken samples were transcribed into SALT and broken into T-units (with mazes and repetitions excluded from the count) and analyzed for syntactic complexity and persuasive content, with special attention paid to mixed claims (i.e., reasons that support both arguments).	CELF-4, TOAL-3, CLPT.	No group differences were found for productivity or syntactic complexity. ABI group produced almost twice as many mazes, half as many supporting reasons, and twice as many tangential utterances as the control group. Working memory was significantly different between the two groups but did not appear to influence performance on the discourse task.

(table continues)

(Hall et al., 2021)

Table 3. *(Continued).*

Study	Procedure	Outcome measures used	Other forms of assessment used	Results
Instrumental activity of daily living (IADL)				
Chevignard et al., 2009	Participants received ingredients, utensils, and step-by-step instructions and were asked to make 2 different recipes within 90 min. Distractor ingredients and utensils were present.	Errors were classified at a descriptive level (e.g., omissions, additions) and then tagged with underlying neuropsychological mechanisms (e.g., context neglect). Researchers recorded the duration of cooking, the number of dangerous behaviors, and the success or failure of the venture.	BADS-C; Prospective Memory subtests of the RBMT-C; TMT-B; WCST; RCF; TOL. Parents were asked to complete the BREF.	Mean number of errors in TBI vs. control group was 99.3 (*SD* = 61.3) vs. 22.5 (*SD* = 11.6), indicating that children with TBI made 4.2 times more errors, on average, but were also much more variable as a group. Task failure was associated with lower scores on tests of executive functioning. More children with TBI were identified by the cooking task than by cognitive tests or questionnaires.
Chevignard et al., 2010	See above.	See above.	D-KEFS; Six Part Test from the BADS-C. Parent questionnaires: BREF; DEX-C.	Children with TBI, including mild TBI, made significantly more errors compared to controls. Results were correlated with several tests and one questionnaire of executive functioning. Internal consistency and test–retest reliability of the CCT were found to be high.
Krasny-Pacini et al., 2015	See above.	See above.	Prospective Memory subtests o f the RMBT and WISC III.	ABI and controls significantly differed in total number of errors, and children who made more errors overall were found to have a lower prospective memory score on the CCT. No significant correlation was found between the PM score on the CCT and the sum of PM raw scores on the RMBT in the ABI group.
Cook et al., 2008	Participants were told to prepare a birthday lunch for a friend. They each completed 3 tasks: making sandwiches, wrapping a birthday present, and writing a birthday card.	Errors were coded as omissions, object substitutions, or action additions. Totals in each category were tabulated, along with the total number of errors.	None. Authors suggest using the BREF and the Six Elements Test in future iterations of the study.	Children with TBI were significantly more likely to use distractor objects in place of target objects compared to controls.

(table continues)

(Hall et al., 2021)

Table 3. *(Continued).*

Study	Procedure	Outcome measures used	Other forms of assessment used	Results
Virtual reality				
Erez et al., 2013	Participants were asked to "shop" for 4 items in a virtual supermarket. Items were listed on a whiteboard in full view of the participants to minimize influence of memory deficits.	Measured duration of task, number, type of mistakes, and feelings of self-efficacy (perceived skill, perceived effort).	Feedback questionnaire; Borg's scale of perceived exertion; Zoo Map subtest of the BADS-C.	All children were able to complete the shopping task in < 20 min and reported "high sense of success" regardless of performance. Mean shopping time and number of mistakes were both higher for children with TBI. VMall scores correctly classified 65% of participants. No significant group differences were found for the Zoo Map subtest, however, Zoo Map scores did boost accuracy of classification by 10% when combined with VMall scores.
Gilboa et al., 2015	Participants viewed a series of numbers on a blackboard in a virtual classroom and tapped to select when a specific digit sequence appeared. Twenty visual, auditory, and mixed audiovisual distractor stimuli were administered.	Counted total number of correct hits, number of commission errors, reaction time, and head movements.	Subtests of the WASI; subtests of the TEA-Ch; CPRS-R.	ABI group made significantly fewer correct hits, though reaction time and head movements were the same. Overall, significant correlations were found between the VMall, TEA-Ch subtest scores, and the CPRS-R:S.
Hanten et al., 2011	Adolescents viewed 6 animated scenarios depicting social conflict between either parents and youth or youth and peers and were asked to define the problem, generate solutions, select solutions, and evaluate the likely outcome.	Scoring was based on a developmental scale in which responses were judged as impulsive, unilateral, reciprocal, or collaborative, in order of increasing score.	Neuroimaging of cortical gray matter thickness of orbitofrontal regions, frontal pole, cuneus, and temporal pole. WASI; CELF-3; GORT-4.	Significant group differences were strongest and most consistent for defining the problem and evaluating outcomes. Performance was inversely related to complexity of scenario in youth with TBI. Increases in cortical thickness in the temporal pole and the cuneus were related to better performance.
Structured cognitive task				
Dennis et al., 2013	Six pictured situations with standard captions were narrated with neutral, ironic, or empathic intonation. Participants were asked 2 factual, 2 belief, and 2 intent questions about each image.	Factual questions were scored as correct or incorrect. Belief and intent questions were scored as correct (2), underspecified (1), or incorrect (0).	Neuroimaging of injury severity, including diffuse and focal CT abnormality scores (when available).	Group differences emerged on indirect speech acts, but not on direct speech acts. In general, belief was easier to understand than intention; however, the severe TBI group demonstrated significant difficulty with belief as well.
Shanahan et al., 2011	Participants were asked to organize an imaginary party using a color-coded chart as a visual planning aid while also narrating their process out loud.	Analysis of visual planning aid, verbal protocol. Each visual planning aid was coded for errors (omission, time, allocation).	None reported.	Provided insight into not only effectiveness and efficiency, but also independent use of strategies (including chunking, monitoring, and self-evaluation).

(Hall et al., 2021)

Questionnaires

-Recognize and consider:

- Possible "Symptoms" and how they may manifest for different tasks and on different days
- Student's own report
- Changes between before and after concussion

Medical Based Questionnaire
Acute Concussion Evaluation (ACE): Physician/Clinician Office Version

B. Symptom Check List* Since the injury, has the person experienced any of these symptoms any more than usual today or in the past day?
Indicate presence of each symptom (0=No, 1=Yes). ***Lovell & Collins, 1998 JHTR***

PHYSICAL (10)			COGNITIVE (4)			SLEEP (4)			
Headache	0	1	Feeling mentally foggy	0	1	Drowsiness	0	1	
Nausea	0	1	Feeling slowed down	0	1	Sleeping less than usual	0	1	N/A
Vomiting	0	1	Difficulty concentrating	0	1	Sleeping more than usual	0	1	N/A
Balance problems	0	1	Difficulty remembering	0	1	Trouble falling asleep	0	1	N/A
Dizziness	0	1	**COGNITIVE Total (0-4)** _____			**SLEEP Total (0-4)** _____			
Visual problems	0	1	**EMOTIONAL (4)**						
Fatigue	0	1	Irritability	0	1				
Sensitivity to light	0	1	Sadness	0	1				
Sensitivity to noise	0	1	More emotional	0	1				
Numbness/Tingling	0	1	Nervousness	0	1				
PHYSICAL Total (0-10) _____			**EMOTIONAL Total (0-4)** _____						
(Add Physical, Cognitive, Emotion, Sleep totals) Total Symptom Score (0-22)					_____				

Exertion: Do these symptoms worsen with:
Physical Activity __Yes __No __N/A
Cognitive Activity __Yes __No __N/A

Overall Rating: How different is the person acting compared to his/her usual self? (circle)
Normal 0 1 2 3 4 5 6 Very Different

(Gioia & Collins, 2006)

Student/Guardian Questionnaires

Gioia et al. (2012) created questionnaires for children and adolescents (and family/caregiver) ages 5+.

Questions considering:

- Sensory responses (vision, loud noises)
- Sleep and fatigue
- Mood (sad/depressed, anxious)
- Physical (Headaches, balance)
- (Sort of) receptive/expressive language

Role of speech-language pathologist leads to additional questions

Assessment Interpretation

You have your assessment data, now what?

- Identify strengths/weaknesses compared to baseline
- Consider future coursework
- Think about every task in context of an environment (classroom, even field)
- Consider supports that would make it easier

Collaboration with student, parent, medical team, teachers will be essential to supporting this patient

Continue to monitor over time

School Interventions

So what do these students need?

(Rocky Mountain Children's Health Foundation, 2011)

Accommodations

- Not one size fits all
- May need to consider alternative make up work for missed school assignments or absence forgiveness
- Alternative assignments and/or limiting homework upon return to school
- Additional time
- 1:1 support
- Preferential seating
- Separate environment for tests/quizzes
- Ability to leave class to take breaks as needed

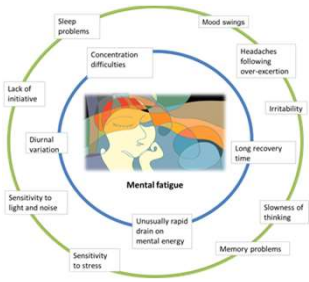
Accommodations/Strategies

To assist memory (and attention/language):

- Add visual support (written directions, pictures, symbols, key words)
- Access to lectures in writing (PowerPoint)
- Note taking support
- Audio record class
- "Cheat sheets" or formula pages
- List out steps needed to complete task
- Have student repeat instructions in their own words
- Do a walk through of directions (maybe younger students)
- Mutual understanding of words/vocabulary

What is Cognitive Fatigue?

Defined as "A transient increase in mental exhaustion resulting from prolonged periods of cognitive activity. Cognitive fatigue can be described as feelings of mild to extreme mental exhaustion which can last anywhere from several hours to days and is often felt as a rebound effect after mental exertion" (Wylie & Flashman, 2017).



Illustrated by: Kristina Edgren Nyborg
Taken from (Johansson & Rönnbäck 2014)

Strategies for Managing Cognitive Fatigue

1. Measure the time frame during which you are at your cognitive "best" (before symptoms start).
2. Plan out your homework/studying within this window and place the hardest subjects first.
3. When studying at home, try taking a break 5 minutes before the end of that timeframe (before symptoms start).
4. Eat a snack and drink a lot of water during break.
5. See if you can return to the activity and work about the same amount as initial time.
6. As you progress, try to add more works sessions with breaks.
7. Experiment with extending your cognitive work time by 1-2 minutes beyond your set threshold. This could help gradually increase your endurance.
8. Manage headaches and dizziness as these can contribute to cognitive fatigue.
9. Make sure you are getting adequate exercise, nutrition, hydration, and rest.
10. Advocate for yourself and do not be afraid to ask for help.

(Stevens-Yu, 2018

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