

### Viewing Time

The program will take up to one hour to complete.

### Target Audience

This program is designed for primary care physicians.

Other health care professionals working with patients and their families may also find this program of interest.

### Faculty Disclosure

It is the policy of Children's Hospitals and Clinics of Minnesota to ensure balance, independence, objectivity, and scientific rigor in all its educational programs. Our faculty have been asked to disclose to our program audience any real or apparent conflicts of interest related to the content of their presentation. They have also been requested to let you know when any product mentioned in their presentation is not labeled for the use under discussion or is still under investigation.

### Faculty Disclosure

**Leslie Larson, RN, CNP, CIC, CBIS** has disclosed no actual or potential conflict of interest in relation to this educational activity.

During this educational activity **Ms. Larson** will not be discussing the use of any commercial or investigational product not approved for any purpose by the FDA.

### Mild Traumatic Brain Injury and ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing)

**Leslie Larson, RN, CNP, CIC, CBIS**  
Credentialed ImPACT Consultant, Certified Brain Injury Specialist

### Mild Traumatic Brain Injury and ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing)

*A lecture about the diagnosis of concussions in children and the use of ImPACT to evaluate the progress of their recovery.*

## Program Objectives

*Upon completion of this program, participants should be able to:*

- Define a mild traumatic brain injury
- Identify 3 causes of mild traumatic brain injury
- Describe the purpose of neurocognitive testing
- List five signs and symptoms of a concussion

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## Receiving CME Credit

To receive CME credit you must view the entire program and complete the evaluation form at the end.

## Traumatic Brain Injury

Leslie Larson RN, MSN, CNP  
Certified Brain Injury Specialist  
Credentialed ImPACT Specialist  
Gillette Children's Specialty Healthcare

## Objectives

- Following this presentation the learner will be able to:
  - Define a mild traumatic brain injury (TBI)
  - Identify three causes of mild TBI
  - Describe the purpose of neurocognitive testing
  - List five signs and symptoms of a concussion
  - Identify who would be an appropriate candidate for ImPACT testing

## Traumatic Brain Injury (TBI)

- “Defined as a complex pathophysiologic process affecting the brain induced by traumatic biomechanical forces secondary to direct or indirect forces to the head.”

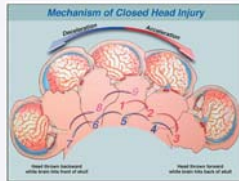
[http://www.cdc.gov/ncipc/tbi/Facts\\_for\\_Physicians\\_booklet.pdf](http://www.cdc.gov/ncipc/tbi/Facts_for_Physicians_booklet.pdf)  
[http://www.cdc.gov/ncipc/tbi/Facts\\_for\\_Physicians\\_booklet.pdf](http://www.cdc.gov/ncipc/tbi/Facts_for_Physicians_booklet.pdf)

## Types of TBI

- A direct blow
- A penetrating injury
- Rapid acceleration/deceleration
- Rotational injury

## Acceleration/Deceleration

- Brain moves forward in skull
- Frontal lobes strike inside of skull
- Rebound contre coup injury to the occipital lobe



## Rotational injury

- Brain rotates on axis causing stretching/tearing of axon
- Stretching and tearing of blood vessels results in hematoma
- Brain strikes skull causing contusion

## Traumatic Brain Injury (TBI)

- Rapid onset of short lived impairment of neurological function that resolve spontaneously
- May result in neuropathological changes
  - Acute clinical symptoms reflect a functional disturbance rather than structural injury

## Traumatic Brain Injury (TBI)

- May result in
  - Physical symptoms
  - Cognitive changes
  - Emotional changes
  - Sleep disturbance
- Symptoms may last minutes, days, weeks, months or even longer.

## Traumatic Brain Injury

- Results in a graded set of clinical syndromes that may or may not involve loss of consciousness.
- Resolution of the clinical and cognitive symptoms typically follows a sequential course
- Typically associated with grossly normal neuroimaging studies

## Grading Scales

- Cantu revised Guidelines
- Colorado Medical Society Guidelines
- American Academy of Neurology
- International Symposium

## Grading Scales

- What grading scales do
  - Provide a definition of mild, moderate and severe traumatic brain injury
  - Provide recommendations for return to activity
  - Relies solely on the athlete's honesty regarding symptoms

## What grading scales are not

- They are not evidenced based
- Not individually based
- No concrete data is used to make decision

## International Symposium

- Organized by
  - International Ice Hockey Federation (IIHF)
  - Federation Internationale de Football (FIFA)
  - International Olympic Committee Medical Commission (IOC)
- Developed summary and agreement statements

## International Symposium

- Recommends not using grading scales
- Concussion severity can only really be determined after all symptoms have cleared exam normal and cognitive return to baseline
- Limited published data showing that severity correlates with # and duration of s/s or degree of neuropsychological impairment

## Assessment

- Neurological exam
- Neuropsychological testing
- Objective balance assessment
- Neuroimaging
- Genetic testing

## Treatment

- Physical rest
- "Cognitive" rest
  - Child needs to limit exertion with activities of daily living and limit scholastic activity while symptomatic rest
- Pharmacology
  - Management of specific symptoms
  - Modify underlying pathophysiology of the condition

## Traumatic Brain Injury (TBI)

- TBI can cause functional changes
  - Thinking (memory and reasoning)
  - Sensation
  - Language (communication, expression, and understanding)
  - Emotion (depression, anxiety, personality changes, aggression, acting out, social inappropriateness)

<http://www.cdc.gov/ncipc/tbi/Outcomes.htm>

## Second Impact Syndrome

- Occurs when a child sustains a concussion, and has not fully healed, before sustaining another concussion.
- Can cause death or permanent disability
- Is 100% preventable

## Neurometabolic Cascade of Concussion

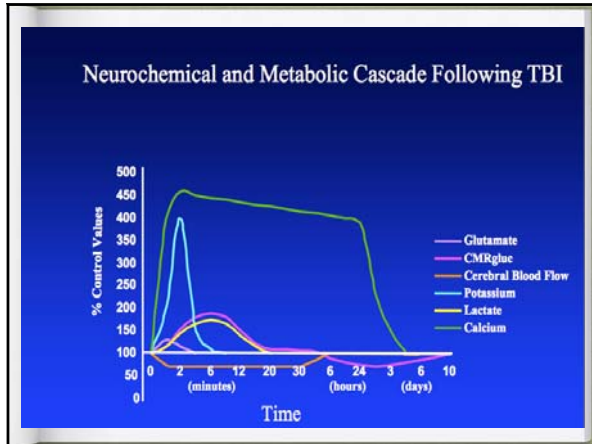
- Impact strong enough to trigger a concussion.
- All the brain cells begin to fire.
- Neurotransmitters are released
- Activate receptors
- Receptors release ions

Giza, C., Hovda, D.A. (2001) The neurometabolic cascade of concussion *Journal of Athletic Training* 36 (3), 228-235

## Neurometabolic Cascade of Concussion

- Cells activate pumps
  - Potassium ions out
  - Calcium ions into the cells
- To move the ions back, brain increases metabolism
- Calcium impairs the cells
  - Can't make the energy to drive the ion pumps

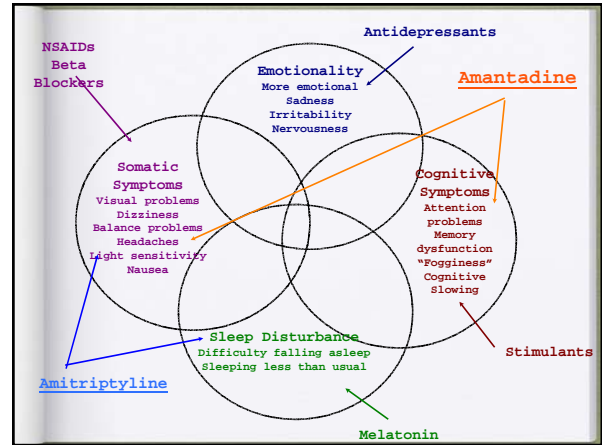
Giza, C., Hovda, D.A. (2001) The neurometabolic cascade of concussion *Journal of Athletic Training* 36 (3), 228-235



### So what does this all mean?

- After a concussion, your brain has an increased need for energy, but you have a deficiency in the ability to make energy.
- Essentially the cells turn off and become quiet.
- Recovery depends on several factors

Physical Symptoms	Cognitive Symptoms	Emotional symptoms	Sleep Symptoms
Headache	Feeling mentally "foggy"	Irritability	Drowsiness
Nausea	Feeling slowed down	Sadness	Sleeping more
Vomiting	Difficulty concentrating	More emotional	Sleeping less
Balance problems	Difficulty remembering	Nervousness	Trouble falling asleep
Dizziness	Forgetful of recent events		
Visual problems	Confusion about recent events		
Fatigue	Answers questions more slowly		
Sensitive to light	Repeats questions		
Sensitive to noise			
Numbness/tingling			
Dazed/Stuned			



### Return to activity

- Athletes should complete the following step-wise process prior to return to play following concussion.
- Return to activity should be individually decided

### Acute Management

- Removal from contest
- No return to play in current game
- Medical evaluation following injury
- Rule out more serious intracranial pathology
- Neuropsychological Testing considered "cornerstone" or proper post-injury assessment

## Return to Activity Plan

Low levels of physical exertion	This includes walking, light jogging, light stationary biking, light weightlifting (lower weight, higher reps, no bench, no squat). 40% of maximum heart rate
Moderate levels of physical exertion	This includes moderate jogging, brief running, moderate intensity stationary biking, moderate intensity weightlifting (reduced time and/or reduced weight from typical routine 60% of maximum heart rate
Heavy non-contact physical exertion	This includes sprinting/running, high intensity stationary biking, regular weightlifting routine, non-contact sport specific drills. 80% of maximum heart rate

## Key things to remember

- No athlete should return to play with symptoms of concussion
- All athletes should be properly evaluated after concussion
- Football has greatest risk
- Soccer, wrestling, hockey, lacrosse, girls/boys basketball, cheerleading also carries significant risk
- Proper management of concussion is the best form of prevention

## Forms



- Minor Neurotrauma Clinic Instructions
- Return to physical activity form
- Letters to the school

## Recovery Time

- 40% resolve in 1 week
- 60% resolve in 2 weeks
- 80% resolve in 3 weeks
- 1 in 5 take longer than 4 weeks

## Risk factors for protracted recovery

- Age-the younger the longer the recovery
- Repetitive concussions >4
- History of migraines
- Exertion
- Length of retrograde amnesia
- Report of foginess

## ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing)

- A sophisticated research-based software tool
- Purpose to help sports-medicine clinicians evaluate recovery following concussion.

Leslie Larson, RN, CNP, CIC,  
 CBIS Mild Traumatic Brain  
 Injury and ImPACT

### ImPACT

- Evaluates and documents multiple aspects of neurocognitive functioning
- Uses neuropsychological measures
- Contains a Self-Report Symptom Questionnaire
- A Concussion-History Form

### ImPACT

- Seven cognitive tests of cognitive functioning
  - Attention Span
  - Working Memory
  - Sustained Attention
  - Selective Attention
  - Non-verbal Problem Solving
  - Reaction Time

### ImPACT

- Provides a user-friendly injury documentation system
- Provides specific information regarding the severity of injury and a standard for evaluating recovery from injury.
- Takes guess work out of concussion management and return to play decisions

Minnesota High Schools		Minnesota Colleges	Clinics
Aitkin	Park Christian Providence Academy	Concordia College	Bethesda
Albert Lee	Rushford-Peterson	Concordia University	Gillette
Bemidji	Shattuck-St Mary's	MN State Mankato	Itasca Medical
Hill Murray	Spring Lake Park	MN State Moorhead	Mayo
Loyola Catholic Schools	St Peter	Northland Community and Tech College	
Milaca	Totino Grace	St Cloud State	
Moorhead	Woodbury	Univ of MN	
Moorhead North		Univ of MN -Duluth	

### Utilized Throughout Professional and Amateur Sports:

24 NFL Teams	Professional Baseball	Professional Hockey
Swedish World Cup Soccer	USA Women's Olympic Hockey	150 + Neuropsychology Clinics
IRL, CHAMP CAR & Formula One	International Rugby	1000 + High Schools
USA Women's Hockey	300 + Universities	250 + Sports Medicine Centers

### Clinical Protocol for ImPACT

- Baseline
- Concussion
  - ImPACT testing within 24-72 hours
  - Repeat testing in 5-10 days
  - Repeat testing as needed
  - Use normative data when baseline testing not available

### Post-Concussion Symptom Scale

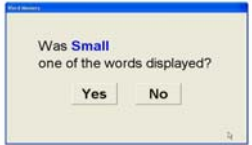
Symptom	None	Minor	Moderate	Severe			
Headache	0	1	2	3	4	5	6
Nausea	0	1	2	3	4	5	6
Vomiting	0	1	2	3	4	5	6
Balance Problems	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Fatigue	0	1	2	3	4	5	6
Trouble Falling Asleep	0	1	2	3	4	5	6
Sleeping More Than Usual	0	1	2	3	4	5	6
Sleeping Less Than Usual	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Sensitivity to Light	0	1	2	3	4	5	6
Sensitivity to Noise	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervousness	0	1	2	3	4	5	6
Feeling More Emotional	0	1	2	3	4	5	6
Numbness or Tingling	0	1	2	3	4	5	6
Feeling Slowed Down	0	1	2	3	4	5	6
Feeling Mentally "foggy"	0	1	2	3	4	5	6
Difficulty Concentrating	0	1	2	3	4	5	6
Difficulty Remembering	0	1	2	3	4	5	6
Visual Problems	0	1	2	3	4	5	6

### Module 1 (Word Discrimination)

- Evaluates attentional processes/verbal recognition memory
- Twelve target words are presented for 750 milliseconds (twice to facilitate learning of the list)
- The subject is then tested for recall via the presentation of the 24-words

### Module 1 (Word Discrimination)

- 12 target words
- Non-target words chosen from the same semantic category as the target word.
- There are five different forms of the word list.
- Delay condition




### Module 2 (Design Memory)

- Evaluates attentional processes and visual recognition memory
- Twelve target designs are presented for 750 milliseconds (twice to facilitate learning)
- The subject is then tested for recall via the presentation of the 24-designs

### Module 2 (Design Memory)

- Comprised of 12 target designs and 12 non-target design
- Delay condition



### Module 3 (X's and O's)

- Measures visual working memory, visual processing speed, and visual memory paradigm
- Incorporates a distractor task.
- The subject can practice the distractor task prior to presentation of the memory task

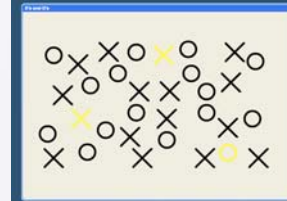
### Module 3 (X's and O's)

- The distractor is a choice reaction time test: the subject is asked to hit "P" if a blue square is presented and "Q" if a red circle is presented.
- Once the subject has completed this task, the memory task is presented.



### Module 3 (X's and O's)

- Memory task: a random assortment of X's and O's is displayed for 1.5 seconds

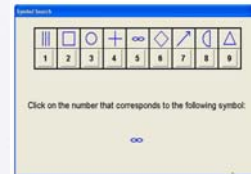


### Module 4 (Symbol Matching)

- Evaluates visual processing speed, learning and memory
- This module provides an average reaction time score and a score for the memory condition.

### Module 4 (Symbol Matching)

- Initially, the subject is presented with a screen that displays 9 common symbols.
- Then the symbols disappear from the top grid.



### Module 5 (Color Match)

- Represents a choice reaction time task and measures impulse control/response inhibition
- Select the word that is same color



### Module 6 (Three letters)

- Measures working memory and visual-motor response speed
- Three letters displayed
- Distractor task
- Asked to remember the 3 letters and their order.



## Module 6 (Three letters)

- Yields a memory score (total number of correctly identified letters) and a score for the average number of correctly clicked numbers per trial from the distractor test.
- Five trials of this task are presented for each administration of the test.

3	19	14	22	17
23	13	8	4	5
16	20	2	7	10
21	11	18	12	9
1	15	25	24	6

## Composite Summary

- In addition to the individual scores also yields summary composite scores for
  - Verbal Memory,
  - Visual Memory,
  - Reaction Time,
  - Processing Speed
  - Impulse Control.

## Verbal Memory Composite

- Is comprised of the average of the following scores:
  - Total percent correct score from Module 1 (Word Discrimination)
  - Total correct hidden symbols from Module 4 (Symbol Matching)
  - Percent of total letters correct from Module 6 (3 Letters)

## Visual Memory Composite

- This score in its current form is comprised of the average of:
  - Total percent correct score from module 2 (Design Memory)
  - Total correct-memory score from module 3 (X's & O's)

## Processing/Visual Motor Speed Composite

- Is comprised of the average of following scores:
  - Total number correct /4 during interference of module 3 (X's & O's)
  - Average counted correctly x3 from countdown phase of module 6 (3 Letters)

## Reaction Time Composite

- Is comprised of the average of the following scores:
  - Average Correct RT of interference stage of module 3 (X's & O's)
  - Average Correct RT /3 of module 4 (Symbol Match)
  - Average Correct RT of module 5 (Color Match)

## Impulse Control Composite

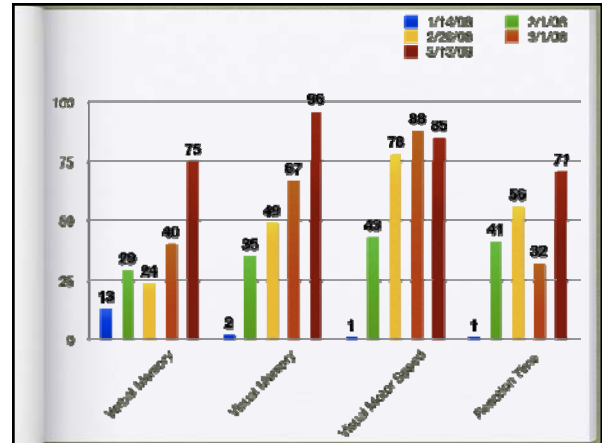
- Sum of errors committed during different phases of the test
- This score is obtained by adding:
  - Total errors on the interference phase of module 3 (X's & O's)
  - Total commissions from module 5 (Color Match)

## Normative data

- A/B student, high SAT scores, high standardized test scores expect 75% or greater
- B/C student, average SAT scores, average standardized test scores expect 50% or greater
- D/F student/LD student, low SAT scores, low standardized test scores expect 20% or greater

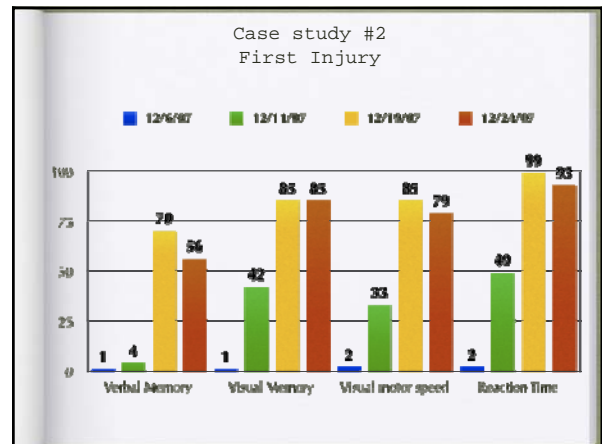
## Case Study

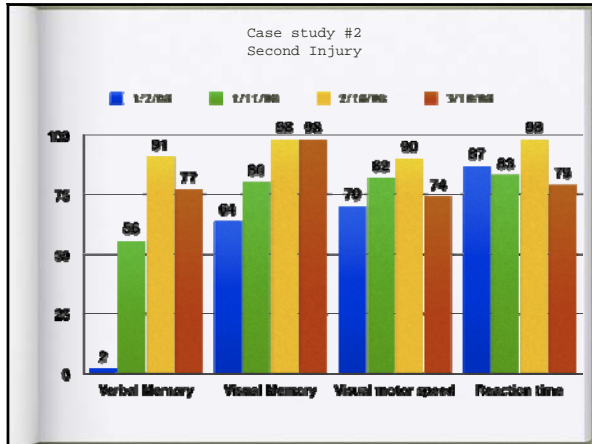
- T.C. is a 14 year old male
- Freshman Football Player
  - Left outside linebacker
- Injured October 17, 2007.
  - Dad noted in 2nd half of game T.C. was stumbling frequently
  - First evaluation November 2007



## Case Study #2

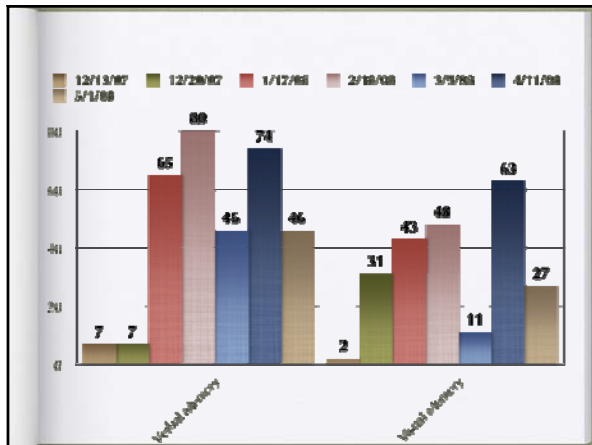
- BB is a 17 year old male
- Injured playing soccer
  - Plays goalie





## Case Study

- KJ is a 10 year old boy
- Injured playing hockey
- Suffered right frontal contusion
- Seizure 1 day after injury
- Status seizure 4 days after injury



## Comments and Questions

*Thanks for viewing  
 this presentation!*

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 Medical Marketing & Education

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 the CME Eval button below  
 and complete the form.*



# ImPACT™ Clinical Report

[Redacted]

[Redacted]

Organization: Gillette Childrens Specialty  
Subject ID#: Healthcare  
Test ID

Date of Birth: [Redacted] Age: [Redacted]  
Gender: Male Height:  
Handedness: Right Weight:

Native country/region: United States  
Native language: English

Years of education completed excluding kinder garden: 10 Repeated one or more years of school: No  
Received speech therapy: No Diagnosed learning disability: No  
Attended special education classes: Yes Problems with ADD/hyperactivity: Yes

Current sport: Soccer Current level of participation: High School  
Primary position/event/class: goalie Years of experience at this level: 2

Number of times diagnosed with a concussion (excluding current injury): 4  
Concussions that resulted in loss of consciousness: 0  
Concussions that resulted in confusion: 2  
Concussions that resulted in difficulty remembering events that occurred immediately after injury: 0  
Concussions that resulted in difficulty remembering events that occurred: 0  
Total games missed as a result of all concussions combined: 10  
Concussion history: [Redacted]

Treatment for headaches by physician: No History of meningitis: No  
Treatment for migraine headaches by physician: No Treatment for substance/alcohol abuse: No  
Treatment for epilepsy/seizures: No Treatment for psychiatric condition (depression, anxiety): No  
History of brain surgery: No



# IMPACT™ Clinical Report

[REDACTED]

Exam Type	Post-Injury 1	Post-Injury 2	Post-Injury 3	Post-Injury 4	Post-Injury 4
Date Tested	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
Last Concussion	12/01/2007	12/01/2007	12/01/2007	12/01/2007	12/29/2007
Exam Language	English	English	English	English	English
Test Version	2.0	2.0	2.0	2.0	2.0

Composite Scores										
Memory composite (verbal)	52	<1%	65	4%	90	70%	86	56%	61	2%
Memory composite (visual)	46	1%	73	42%	89	85%	88	85%	80	64%
Vis. motor speed composite	26.83	2%	35.92	33%	47.4	85%	45.75	79%	43.53	70%
Reaction time composite	0.82	2%	0.58	49%	0.43	99%	0.48	93%	0.5	87%
Impulse control composite	31		21		23		31		49	
Total Symptom Score	12		4		0		0		3	

Percentile scores if available are listed in small type.

Hours slept last night	7	7	8	9	7.5
Medication	*	^	#	&	

\* Daytrana - took test at 4pm patch placed at 3:00pm

^ ADHD Patch

# Daytrana

& Daytrana Patch

| Daytrana

The information provided by this report should be viewed as only one source of information regarding an individual's level of (neurocognitive) functioning. Even though impact is based on demonstrated scientific principles and research, external factors such as improper test administration or improper test taking environment may result in inaccurate test results. These factors and others must be considered in making return-to-play decision. The information provided by this report is of a general nature and does not represent medical advice, a diagnosis, or prescription for treatment. Additionally, diagnostic or return to play decisions should not be based solely on the data generated by this report, but on an in-person evaluation made by a professional trained in concussion management in accordance with usual and standard medical practice. An individual suspected of suffering traumatic brain injury or concussion should immediately seek the advice of qualified and trained personnel for interpretation of test results and should be monitored closely for the emergence of symptoms. Impact is not responsible for any decisions based on information contained in the report. A test-taker's qualified and trained personnel has the sole responsibility for establishing diagnosis and suggesting appropriate treatment.



# ImPACT™ Clinical Report



Word Memory					
Hits (Immediate)	4	10	10	10	12
Correct distractors (Immed.)	10	9	12	12	12
Learning percent correct	58%	79%	92%	92%	100%
Hits (delay)	7	8	5	5	2
Correct distractors (delay)	7	5	10	12	11
Delayed memory pct. correct	58%	54%	63%	71%	54%
Total percent correct	58%	66.5%	77.5%	81.5%	77%

Design Memory					
Hits (Immediate)	7	6	10	6	12
Correct distractors (Immed.)	5	12	8	12	12
Learning percent correct	50%	75%	75%	75%	100%
Hits (delay)	8	9	11	8	5
Correct distractors (delay)	4	7	8	10	12
Delayed memory pct. correct	50%	67%	79%	75%	71%
Total percent correct	50%	71%	77%	75%	85.5%

X's and O's					
Total correct (memory)	5	9	12	12	9
Total correct (interference)	73	105	108	102	89
Avg. correct RT (Interfer.)	0.73	0.48	0.42	0.41	0.4
Total incorrect (Interference)	27	19	23	31	49
Avg. incorrect RT (Interfer.)	0.58	0.36	0.33	0.32	0.26

Symbol Match					
Total correct (visible)	24	27	26	27	27
Avg. correct RT (visible)	1.64	1.34	1.03	1.2	1.25
Total correct (hidden)	4	5	9	8	6
Avg. correct RT (hidden)	2.85	2.32	1.67	1.57	1.58

Color Match					
Total correct	8	9	9	9	9
Avg. correct RT	1.17	0.82	0.54	0.63	0.69
Total commissions	4	2	0	0	0
Avg. commissions RT	1.07	0.46	0	0	0

Three Letters					
Total sequence correct	2	3	4	4	2
Total letters correct	8	11	14	13	6
Pct. of total letters correct	53.33%	73.33%	93.33%	86.67%	40%
Avg. time to first click	1.82	2.68	1.25	1.57	1.83
Avg. counted	12.2	15.2	22.6	22.2	21.6
Avg. counted correctly	11.8	15.2	22.6	22	21.6



# ImPACT™ Clinical Report



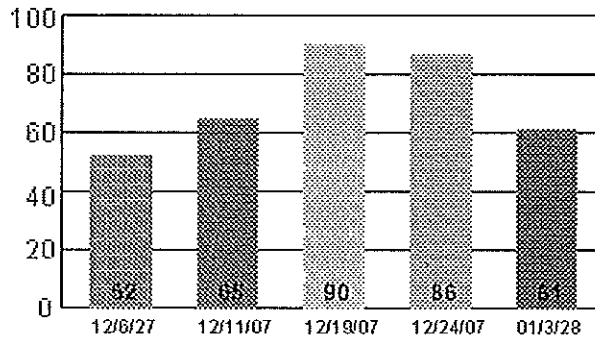
Headache	2	2	0	0	1
Nausea	0	0	0	0	0
Vomiting	0	0	0	0	0
Balance Problems	0	0	0	0	0
Dizziness	1	0	0	0	1
Fatigue	2	0	0	0	0
Trouble falling asleep	1	0	0	0	1
Sleeping more than usual	0	1	0	0	0
Sleeping less than usual	0	0	0	0	0
Drowsiness	0	0	0	0	0
Sensitivity to light	0	0	0	0	0
Sensitivity to noise	0	0	0	0	0
Irritability	0	0	0	0	0
Sadness	0	0	0	0	0
Nervousness	2	1	0	0	0
Feeling more emotional	0	0	0	0	0
Numbness or tingling	0	0	0	0	0
Feeling slowed down	2	0	0	0	0
Feeling mentally foggy	0	0	0	0	0
Difficulty concentrating	1	0	0	0	0
Difficulty remembering	1	0	0	0	0
Visual problems	0	0	0	0	0
<b>Total Symptom Score</b>	<b>12</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>3</b>



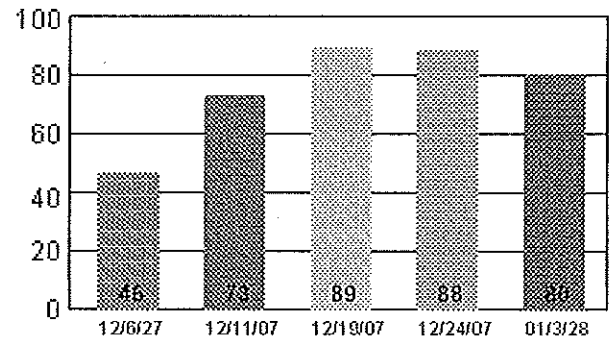
# ImPACT™ Clinical Report



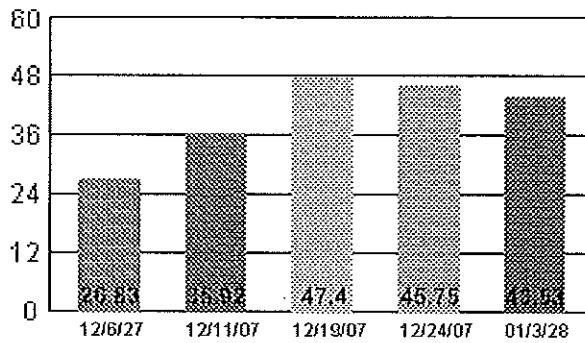
Memory Composite (Verbal)



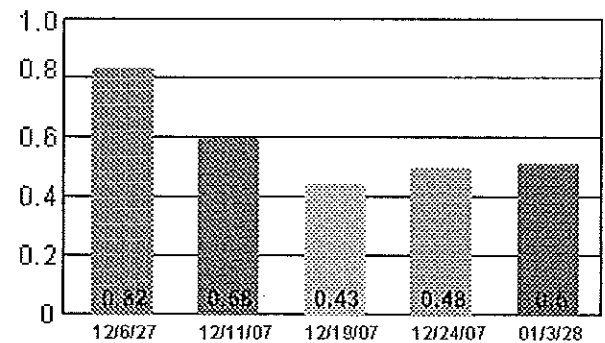
Memory Composite (Visual)



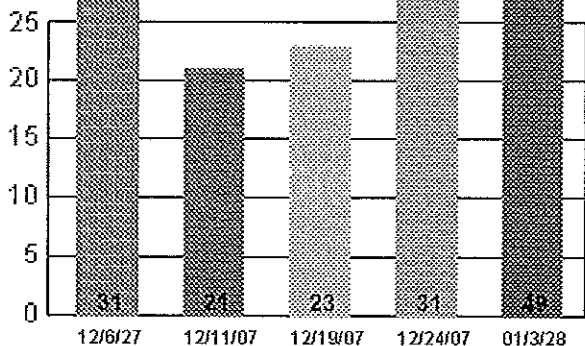
Visual Motor Composite



Reaction Time Composite



Impulse Control Composite



Symptom Score

