How to Effectively Use and Interpret Computerized Neurocognitive Testing: Case studies from Certified Athletic Trainers

Presenters:
Peter C. Entwistle PhD
Brian Coley ATC, LAT
Tim McLane MBA, ATC, LAT

Concussion Vital Signs

Contains seven venerable computerized neuropsychological tests... and the clinical domains, scored from the tests, measures the speed and accuracy of an athlete's brain or neurocognitive function.
CVS Normative Data:

• Normative sample characteristics:
  – In good health
  – No past or present psychiatric or neurological disorders, head injury, or learning disabilities
  – Free of any centrally acting medications.

• Age-based (10 groups)
Frequently asked questions about neurocognitive testing of student athletes...

<table>
<thead>
<tr>
<th>CLINICAL DOMAINS</th>
<th>CLINICAL DOMAIN SCORE CALCULATIONS</th>
<th>CLINICAL DOMAIN DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Functioning</td>
<td>Executive Functioning requires fluid cognition to solve problems.</td>
<td>Measures: How well subjects process information, solve problems, and perform multiple tasks simultaneously. Performance is measured using the Stroop Test.</td>
</tr>
<tr>
<td>Cognitive Flexibility</td>
<td>Cognitive Flexibility requires shifting and managing multiple tasks simultaneously.</td>
<td>Measures: How well subjects can adapt to new situations and effectively manage multiple tasks simultaneously, as well as shifting and incorporating new information.</td>
</tr>
<tr>
<td>Digit Span</td>
<td>Digit Span measures memory and attention.</td>
<td>Measures: How well subjects can keep track of and respond to information over lengthy periods of time and perform mental tasks requiring efficient and sustained attention. Performance is measured using the Digit Span Test.</td>
</tr>
</tbody>
</table>

An * denotes that "lower is better" in the Subject Score column, otherwise higher scores are better. With Percentile scores, higher is always better.
Who should interpret the CVS neurocognitive test results?

- State legislation and medical guidelines generally require a medical or physician release for athletes to return-to-play.
- Interpretation of the Concussion Vital Signs neurocognitive test results should be done by a qualified health professional.
- As expressed in the Consensus statement on concussion in sport held in Zurich, November 2008. “Neuropsychologists are in the best position to interpret NP tests by virtue of their background and training.
- However, there may be situations where neuropsychologists are not available and other medical professionals may perform or interpret NP screening tests.”

What does Neurocognitive Index (NCI) mean?

- The Neurocognition Index – NCI, reflects the overall neurocognitive functioning of the athlete test taker. It is an average of all the domains into a global summary score.
- Because many concussions are complex and diagnosis is difficult, it usually requires clinicians to take a multidimensional approach to their assessment.
- Therefore, the NCI and the other neurocognitive domain scores should be taken in context with the symptom scores, history and physical, as well as other tests and relevant clinical endpoints.

What is “Executive Functioning”?

- Executive Functioning, sometimes called executive control system, is generally considered a frontal lobe (see blue section of picture) cognitive system that controls and manages other cognitive processes.
- It is considered a higher-order brain function which includes attention, behavioral planning and response inhibition, and the manipulation of information in problem-solving tasks.
- Sometimes referred to as the “command and control” function (frontal lobe), the executive function can be viewed as the “conductor” of many cognitive skills.
- The SAT - Shifting Attention Test (rules, categories, rapid decision-making) results are used to calculate this frontal lobe domain.
If a student athlete does not have a baseline, can he/she be given a post-injury test?

- Baseline testing can serve as a valuable "premorbid" (state prior to condition) point of comparison for the testing that is conducted after the concussion injury.
- However, even if baseline neuropsychological testing has not been performed, post-injury neuropsychological testing can still be a very useful source of information about the effects of the concussion.
- Using standardized PERCENTILE scores can help clinicians identify poor cognitive function performance which can be an important indicator that the brain is not working normally.
- However, there are many reasons test performance can be abnormal, including concussion.

What combinations of test scores should cause you to look for some underlying conditions?

- Every student athlete is different; there is no "one-size fits all" answer to assessing concussion.
- Neurocognitive domain score performance may vary depending on a number of factors that include testing effort, type of blow to the head, location or site of the blow, and the patient’s individual history.
- The Consensus statement on concussion in sport held in Zurich, November 2008 states “…the assessment of cognitive function should be an important component in any return to play protocol.
- It must be emphasized, however, that NP assessment should not be the sole basis of management decisions; rather it should be seen as an aid to the clinical decision-making process in conjunction with a range of clinical domains and investigational results.”
Allows for Post injury comparisons over time

Post-Injury #2 Example

Ongoing monitoring
**Concussion Vital Signs Product Training**

**Additional features:**
Concussion Symptom Scale

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Baseline</th>
<th>Post-Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue or loss of energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consequences of being sleepy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling like &quot;in a fog&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty communicating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blurred vision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Concussion Vital Signs Product Training**

**Additional Concussion Symptoms**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Baseline</th>
<th>Post-Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty telling or staying active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobility, words accessed or slowed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling confused or thinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue in the day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Migraine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More tired</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling nervous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling anxious</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling frustrated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling shocked</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling dizzy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Do symptoms get worse with Physical Activity: No*

*Do symptoms get worse with Mental or Academic Activity: No*
### Concussion History Report

- **Demographic and Background Information – Education**
  - Years of Education Completed (e.g., high school senior is 11 years):
  - SAT – ACT (total):
  - Received Speech Therapy:
  - Attended Special Education Classes:
  - Repeated One or More Years of School:
  - Diagnosed Attention Deficit Disorder (ADD) or (ADHD):
  - Diagnosed Learning Disability:

### Demographics

- **Demographic and Background Information – Sports**
  - Primary Sport:
  - Primary Sport Position:
  - Years you have played this primary sport at current level:
  - Total number of years you have played this primary sport:
  - Secondary Sport:
  - Secondary Sport Position:
  - Years you have played this secondary sport at current level:
  - Total number of years you have played this secondary sport:
**Medical History**

- Concussion & Medical History
  - Number of times diagnosed with a concussion:
  - Injury 1 (Up to 3 injuries can be reported)
  - Approximate Date of Injury:
  - Days Lost:
  - Was this concussion sports related?
  - Did this concussion result in a loss of consciousness?
  - Did this concussion result in confusion?
  - Difficulty remembering events immediately before injury?
  - Difficulty remembering events immediately after injury?

**Prior Treatment**

- Indicate whether you have experienced the following:
  - Treatment for Headaches by Physician:
  - Treatment for Migraine Headaches by Physician:
  - Treatment for Epilepsy / Seizures:
  - History of Brain Surgery:
  - History of Meningitis:
  - Treatment for Substance / Alcohol abuse:
  - Treatment for Psychiatric Condition (depression / anxiety etc.):
  - Current Medications:

**CASE STUDY #1**

CONCUSSION IN A HIGH SCHOOL ATHLETE

Brian Coley ATC, LAT
WHAT IS A CONCUSSION?
• A concussion is a brain injury
• Is caused by a bump or blow to the head
• Can change the way your brain normally works
• Can occur during practice or games in any sport
• Can happen even if you have not been knocked out
• Can be serious even if you have just been “dinged”

WHAT ARE THE SYMPTOMS OF A CONCUSSION?
• Headache or “pressure” in head
• Nausea or vomiting
• Balance problems or dizziness
• Sensitivity to light
• Sensitivity to noise
• Feeling sluggish, hazy, foggy or groggy
• Concentration or memory problems
• Confusion
• Does not “feel right”

WHAT ARE THE SYMPTOMS REPORTED BY ATHLETES?
• Headache or “pressure” in head
• Nausea or vomiting
• Balance problems or dizziness
• Sensitivity to light
• Sensitivity to noise
• Feeling sluggish, hazy, foggy or groggy
• Concentration or memory problems
• Confusion
• Does not “feel right”
CONCUSSION/HEAD INJURY FACT SHEET PARENT/GUARDIANS

WHAT ARE THE SIGNS OBSERVED BY PARENTS/GUARDIANS?

• Appears dazed or stunned
• Is confused about assignment or position
• Forgets an instruction
• Is unsure of game, score or opponent
• Moves clumsily
• Answers questions slowly
• Loses consciousness (even briefly)
• Shows behavior or personality changes
• Cannot recall events prior to hit or fall
• Cannot recall events after hit or fall

CONCUSSION AND HEAD INJURY ACKNOWLEDGEMENT — BISHOP KELLEY HIGH SCHOOL

In compliance with Oklahoma Statute Section 24-155 of Title 70, this acknowledgement form is to confirm that you have read and understand the CONCUSSION FACT SHEET provided to you by Bishop Kelley High School related to potential concussions and head injuries occurring during participation in athletics.

I, ____________________________, as a student-athlete who participates in Bishop Kelley High School athletics and I, ____________________________, as the parent/legal guardian, have read the information material provided to us by Bishop Kelley High School related to concussions and head injuries occurring during participation in athletic programs and understand the content and warnings.
Bishop Kelley High School Concussion Protocol July 2012

1. All athletes who participate in a sport in which they may potentially come in contact with another player or surface must have a baseline concussion test taken prior to the beginning of that sport’s season.

2. Yearly baseline testing will begin after May 1st of each school year.

3. If a team holds try-outs and the roster is set, that team must have their baseline testing performed within three days after roster is set. If an athlete has already taken a baseline test from another sport, they do not have to take it again.

4. If an athlete is assessed and a concussion is suspected to have occurred, the post-test needs to be done within 24-48 hours after the suspected concussion.

5. If the post-test shows that there is a 5% or greater difference from the baseline test, the parents will be notified and the athlete must be seen by a physician. A hard copy of the post-test with baseline results included will be sent to the physician with the athlete.

6. Once the athlete sees the physician, a minimum seven (7) day rest period from all activity pertaining to sports begins. It is also recommended that the athlete be given three (3) days of academic rest. Upon returning to class if the student needs accommodations (notes, sunglasses, breaks, etc.) that can be determined by the teacher, students, parents, counselors, and administration. Once the athlete returns to class, should academic stress cause symptoms to return or worsen, extra days off may be required.

7. If an athlete has a post test of 5% or greater and is “released” by the physician, the athlete still must take the minimum seven (7) days of rest, and then perform a post-test again.
8. At the end of the initial seven (7) day rest period an additional post-test will be given to the athlete. If the results and symptoms remain the same with little or no progress, the parents will be notified and the recommendation to see a specialist will be made.

9. At the completion of the initial seven (7) days of rest and if the post-test result is 5% or less, the athlete will begin a gradual return-to-play program. If at any time during the return-to-play program the athlete complains of symptoms, the program will be stopped and followed up with another three (3) days of rest.

Following the three (3) days of rest the athlete will begin the return-to-play program again. The athlete will take a post-test every seven days until the results are 5% or less. Once the results are within the 5% or less range and they are not reporting any symptoms, they will be asked to return to their physician for a follow up. A copy of the most current post-test will again be sent to the physician with the athlete.

At this point it is the determination of the physician to release the athlete fully to play or to continue the period of rest.
### Concussion Vital Signs Post-Injury Report

**Test Date Local:** March 12, 2013 11:30:37

- **Athlete Reference/ID:** XXXXX
- **Concussion Reference Code:** XXXX
- **Full Name:** XXXXX
- **Age:** 15
- **Administrator:** XXXXXX
- **Language:** English (United States)
- **Total Test Time:** 26:48 (min:secs) for all tests in this report
- **Test Date GMT:** March 12, 2013 16:32:15
- **Testing Supervision:** Unsupervised
- **Testing Environment:** Alone

#### Domain Scores

<table>
<thead>
<tr>
<th>Domain</th>
<th>Subject</th>
<th>Percentile</th>
<th>Valid Score</th>
<th>Subject</th>
<th>Percentile</th>
<th>Valid Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory (visual)</td>
<td>93</td>
<td>97</td>
<td>Yes</td>
<td>92</td>
<td>95</td>
<td>Yes</td>
</tr>
<tr>
<td>Memory (verbal)</td>
<td>69</td>
<td>87</td>
<td>Yes</td>
<td>67</td>
<td>85</td>
<td>Yes</td>
</tr>
<tr>
<td>Visual Memory</td>
<td>88</td>
<td>96</td>
<td>Yes</td>
<td>92</td>
<td>99</td>
<td>Yes</td>
</tr>
<tr>
<td>Psychomotor Speed</td>
<td>75</td>
<td>73</td>
<td>Yes</td>
<td>68</td>
<td>78</td>
<td>Yes</td>
</tr>
<tr>
<td>Visual Speed</td>
<td>80</td>
<td>85</td>
<td>Yes</td>
<td>77</td>
<td>78</td>
<td>Yes</td>
</tr>
<tr>
<td>Attention Span</td>
<td>85</td>
<td>82</td>
<td>Yes</td>
<td>87</td>
<td>85</td>
<td>Yes</td>
</tr>
<tr>
<td>Reaction Time</td>
<td>100</td>
<td>100</td>
<td>Yes</td>
<td>100</td>
<td>100</td>
<td>Yes</td>
</tr>
<tr>
<td>Reaction Time (MRT)</td>
<td>99</td>
<td>99</td>
<td>Yes</td>
<td>99</td>
<td>99</td>
<td>Yes</td>
</tr>
<tr>
<td>Choice Reaction Time</td>
<td>92</td>
<td>93</td>
<td>Yes</td>
<td>91</td>
<td>92</td>
<td>Yes</td>
</tr>
<tr>
<td>Writing Attention (WA)**</td>
<td>89</td>
<td>89</td>
<td>Yes</td>
<td>88</td>
<td>88</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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**Notes:**

- All scores are within the normal range.
- Testing was conducted in an unsupervised environment.
- The athlete performed well in all domains with no signs of concussion.
History of Present Illness
She is a goalie for X High School. On 3/2/13 she was going for a ball and another player kicked the ball into her face from 2 feet away. She felt fuzzy and dazed but no LOC. Continued to play that game and the 2 games that followed. She woke the next morning very tired and had headaches and nausea. She was very irritated and emotional. She returned to school on Monday, 3/4/13, and symptoms continued. Trainer at school did a concussion test and told her and her parents she should have a CT to evaluate. CT was negative at X Hospital on 3/5/13, and she did not go to school the next 3 days. Started using computer again on 3/10/13 and returned to school on 3/11/13. Still is not playing soccer but continues to do normal school functions and studying for tests. She states that she is having difficulty concentrating and remembering.
MEDICAL REPORT FROM DOCTOR – 3/13/13  (INITIAL VISIT)

SCAT Subjective Score
76

Assessment/Plan
She is 3.2 days from her 1st concussion from soccer where a girl kicked the ball from 2 feet and it hit her in the face. She has been to urgent care and the ER and had CT of the head which was negative. She returned to school this week and still has bad symptoms. She’s done 2 computer tests which show she is not normal. Start physical and cognitive rest. No TV, texting, studying, reading. No school or soccer activities. Follow up in 9 days for recheck. Do SCATs every 2-3 days. Tylenol as needed for headache. Benadryl as needed for sleep.

MEDICAL REPORT FROM DOCTOR – 3/22/13

History of Present Illness
She is a goalie for X High School. On 3/2/13 she was going for a ball and another player kicked the ball into her face from 2 feet away. She felt fuzzy and dazed but no LOC. Continued to play that game and the 2 games that followed. She woke the next morning very tired and had headaches and nausea. Has been emotional and irritated. School on 3/4/13, was very difficult and made symptoms worse. Trainer in soccer did a concussion test and she did not pass so went to X Hospital and had a CT. On and off school since 3/8/13 until she saw doctor on 3/13/13 and was taken out of school and sports and put on complete rest. She has not been doing much better and is having pain since she cannot take her normal 800 mg ibuprofen 3 times per day. Headaches continue and her SCAT scores are not improving.

MEDICAL REPORT FROM DOCTOR – 3/22/13

SCAT Subjective Score
71

Assessment/Plan
Her symptoms have not improved. Her headache has improved from 5 to 2 today. She has not slept well due to being taken off the ibuprofen 800 mg TID. She has had much pain in the joints and extremities. She is now 3 weeks from her injury for her concussion. Will restart the ibuprofen 800 mg TID. Continue to try Benadryl for sleep. Follow up next week. If not getting increased rest, would consider starting amitriptyline. Continue rest. No school.
MEDICAL REPORT FROM DOCTOR – 3/27/13

History of Present Illness
She is a goalie for X High School. On 3/2/13 she was going for a ball and another player kicked it into her face from 2 feet away. She felt fuzzy but no LOC. Continued to play soccer for the next two days. Her soccer trainer gave a concussion assessment and she failed. X Hospital ER did a CT. She continues to have symptoms. She cannot fall asleep at night but has been sleeping better since she sleeps. Take 800 mg ibuprofen on a daily basis. Has not been to school since 3/13/13. She states she is not doing much better than her last visit on 3/22/13.

SCAT Subjective Score
66

Assessment/Plan
She is not 25 days since being hit in the face with a soccer ball. She feels slight improvement in the past week and is back on 800 mg ibuprofen TID. She is still having difficulty falling asleep. Difficulty concentrating and tried to write a paper for school yesterday which made her worse. Will start on amitriptyline 25 mg at bedtime. Follow up 7-10 days for recheck. If not helping with sleep, consider low dose flexeril. Continue ibuprofen.

MEDICAL REPORT FROM DOCTOR – 4/4/13

History of Present Illness
She is a goalie for X High School. On 3/2/13 she was running after a ball and another player kicked it into her face from 2 feet away. She felt fuzzy but no LOC. Continued to play soccer for the next two days. St Francis did a CT after she failed a concussion assessment at her school. She has not been to school since 3/13/13. Today she states she is doing better but not symptom free. She was given amitriptyline 25 mg on 3/27/13 to help with sleep. She says she is more tired but still not sleeping. Still has headaches and taking ibuprofen 800 mg at night.
SCAT Subjective Score
59
Assessment/Plan
She was kicked with a soccer ball in the face on 3/2/13, which was 4 weeks ago. Head CT at X Hospital was negative. She's been out of school and resting. She is still not sleeping well. By my estimation she is slowly improving. She started amitriptyline 25 mg qhs last week. Will start flexeril 5 mg at bedtime to try to help her fall asleep. Continue amitriptyline. Follow up in 10 days for recheck. Continue to rest and no school.

MEDICAL REPORT FROM DOCTOR – 4/4/13

History of Present Illness
Goalie for X High School. On 3/2/13 she was going for a ball and another player kicked it into her face from 2 feet away. She was fuzzy but no LOC. Continued to play soccer that day and 2 games the next day. Headaches persisted and she went to X Hospital ER and a CT was done. She has not been playing soccer or been to school since 3/5/13. Still has headaches and difficulty sleeping be she states she is doing better. Takes 800 mg ibuprofen and 5 mg flexeril. Also has been on 25 mg amitriptyline for 2 weeks.

MEDICAL REPORT FROM DOCTOR – 4/15/13

SCAT Subjective Score
65
Assessment/Plan
She was kicked in the face with a soccer ball 6 weeks ago. She feels only slightly better. She’s been out of school. Taking amitriptyline 25 mg qhs and flexeril 5 mg but not helping sleep. Will start 1 hour of homework daily. Try flexeril 10 mg qhs. Continue amitriptyline 25 mg. Follow up in 10 days for recheck.
Conclusions

- Have a concussion protocol that outlines what will be done when an athlete suffers a concussion.
- Be willing to educate administrators, coaches, athletes and parents about concussions.
- Take time to read the test results closely and use them to make the proper decision.

CASE STUDY #2
CONCUSSION IN A HIGH SCHOOL ATHLETE

Tim McLane MBA, ATC, LAT

Demographics

- 16 yo male
- 6’ 0”
- Forward in basketball
- Catcher for baseball
- Good health
- No significant injury history for neurological
- Shin splints, PFPS, recent growth gains in last 18 months
More background
- Academically successful and driven
- AP courses and more
- Grades: A; un-weighted 4.0
- Active in church
- Personality: serious, yet will have dry sense of humor; conservative; silent leader

Background continued...
- Generally mature socially, minimal awkwardness
- Very fit, low body fat, but appropriate
- Needs to work on strength more as well as flexibility
- Appropriately aggressive demeanor on the field and the court

Concussion History
- First defined concussion under my purview
- Occurred on January 22
- Denies history of any significant ones in the past. (unclear of previous concussion history)
- Basketball practice running live offense vs. defense
- Shot, rebound, elbow to side of head
More Symptom Issues

• Headaches
• Increased with reading
• DID NOT FOLLOW 48 hour cognitive rest rule – patient ignored our rule
• Noise and crowds in hallway elevated symptoms
• Continued issues with class work
• Referred to neurologist after 10 days and visit to PCP

RTP Protocol

• Graduated return to play protocol
  – Rehabilitation stage functional exercise at each stage of rehabilitation
  – Athlete remains at each stage for 24 hours.
  – 1. No activity Complete physical and cognitive rest
    Recovery
  – 2. Light aerobic exercise
    Walking, swimming or stationary cycling keeping intensity <70% MPHR. No resistance training. Increase HR
  – 3. Sport-specific exercise
    Skating drills in ice hockey, running drills in soccer. No head impact activities. Add movement
  – 4. Non-contact training drills
    Progression to more complex training drills (e.g. passing drills in football and ice hockey). May start progressive resistance training. Exercise, coordination, cognitive load
  – CVS Testing prior to Stage 5.
  – 5. Full-contact practice following medical clearance, participate in normal training activities Restore confidence, assessment of functional skills by coaching staff
  – 6. Return to play Normal game play

CVS Test

• No baseline available
• Tested first time February 26 – five weeks after injury
• Tested initially post injury
• Used normative data to assess
# First Results

<table>
<thead>
<tr>
<th>Domain Scores</th>
<th>Baseline Acceptable</th>
<th>Valid Score</th>
<th>Subject Score</th>
<th>Percentile</th>
<th>Acceptable</th>
<th>Within 1 S.D. of Baseline</th>
</tr>
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<tbody>
<tr>
<td>Neurocognitive Index</td>
<td>No</td>
<td>55</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Verbal Memory</td>
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<td>27</td>
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<tr>
<td>Visual Memory</td>
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<td>47</td>
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<td>No</td>
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<tr>
<td>Psychomotor Speed</td>
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<td>73</td>
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<tr>
<td>Executive Function</td>
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<td>53</td>
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<tr>
<td>Cognitive Flexibility</td>
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<td>Yes</td>
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<tr>
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<td></td>
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</tbody>
</table>

# Second Test – 10 days later

<table>
<thead>
<tr>
<th>Domain Scores</th>
<th>Baseline Acceptable</th>
<th>Valid Score</th>
<th>Subject Score</th>
<th>Percentile</th>
<th>Acceptable</th>
<th>Within 1 S.D. of Baseline</th>
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<tbody>
<tr>
<td>Neurocognitive Index</td>
<td>No</td>
<td>56</td>
<td>Yes</td>
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<td>Verbal Memory</td>
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<td>27</td>
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<td>No</td>
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<td>Visual Memory</td>
<td>No</td>
<td>40</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<td>Psychomotor Speed</td>
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<td>10</td>
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<td>No</td>
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<td>Executive Function</td>
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<td>35</td>
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<td>No</td>
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<tr>
<td>Cognitive Flexibility</td>
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<td>46</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<td>CPT Correct Responses</td>
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<td>41</td>
<td>Yes</td>
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<td>No</td>
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<tr>
<td>Reaction Time</td>
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<td>7.09</td>
<td>Yes</td>
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</tbody>
</table>

# Results Comparison

- **Neurocognitive Index**: No significant change.
- **Verbal Memory**: No significant change.
- **Visual Memory**: No significant change.
- **Psychomotor Speed**: No significant change.
- **Executive Function**: No significant change.
- **Cognitive Flexibility**: No significant change.
- **CPT Correct Responses**: No significant change.
- **Reaction Time**: No significant change.
Indications and Decision

- The first test was also accompanied by minor symptoms after completion
- Another 10 days passed until no symptoms at all
- Second test showed improvements in key areas for our standards and his ability to function athletically
- As well, scholarly function improved during the 10 days (able to function fully in classroom)

Conclusion / Decision

- Allowed to complete our return to play protocol without complication
- Returned to full practice and competition without further symptoms

Summary User Experience

- Testing:
  - Group/individually administered neurocognitive testing
  - Unlimited number of tests given - per athlete for Schools
  - Measures key cognitive skills connected to learning
  - Sideline testing – Pocket SCAT2
  - Athlete Symptom Checklist & Medical History
- Easy to Interpret Reports
- Continuity of care with healthcare provider
Thank you for your interest in Concussion Vital Signs

For more information please contact:
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800-627-7271 x 267147

Or go to:
www.concussionvitalsigns.com