The Role and Value of Neuropsychological Testing

Ruben J. Echemendía, Ph.D.

Keep Your Edge: Hockey Sports Medicine
2015

The American Orthopaedic Society for Sports Medicine
NHL Team Physicians’ Society

August 2015, Toronto
Disclosures
Neuropsychological Assessment

• The brain is the most complex organ in the body, controlling all of its functions.
• Fully assessing the functioning of the brain is equally complex.
• It cannot be done quickly, with one measure, or by people inadequately trained to do so.
Neuropsychological Testing

- Neuropsychological testing examines what the brain does.
- Learning, Memory, Information Processing Speed, Problem Solving Skills, Cognitive Flexibility
- Emphasis on functional rather than structural assessment
- Can be repeated serially during recovery
- Provides quantitative indices of neurocognitive functioning.
Because neuropsychological testing is designed to measure cognitive functioning…

…It can be affected by a variety of factors that influence cognitive functioning:

• Physiological (e.g., Sleep, dehydration, blood glucose levels).
• Psychological (e.g. Depression, Anxiety).
• Environmental (e.g. Noise, heat, visual stimulation, distractions).
• Cultural, linguistic, educational history
Neuropsychological Testing Cont.

- Neuropsychological tests are also affected by measurement error inherent in the tests, or...
- Individual variability among players.

- The key is to separate the signal from the noise.
Differentiating Between Brief Cognitive Screening and Neuropsychological Assessment

• Brief measures of cognitive functioning (e.g. SAC, SCAT) are designed as screening measures.
• They only assess isolated domains of functioning in very rudimentary ways.
• Typically have marked ceiling effects.
• Generally lose sensitivity within a short period of time (e.g. 72 hours).
• Good for identifying acute, significant neurocognitive dysfunction.
• Not good for RTP.
Differentiating Between Brief Cognitive Screening and Neuropsychological Assessment

- Sports Concussion Batteries are far less comprehensive than traditional NP batteries.
- But, much more comprehensive than screening batteries.
- Not practical in the acute phase of injury for most settings.
- More useful for management, determining severity of cognitive dysfunction, and assisting in RTP decisions.
Important to Remember

Neuropsychological tests should NEVER be used in isolation to make RTP decisions.
Tests Used in Sports TBI....

Yo, Dewey! Got another one over here when you're done.
Trail Making Test
Paper & Pencil Tests

• Advantages:
  – Direct observation of player behavior
  – Direct monitoring of effort/motivation & task performance
  – Superior assessment of memory
  – Broad normative db with multiple samples.

• Disadvantages:
  – Labor intensive (Expensive)
  – Variability in standardized admin
  – Less reliable assessment of info proc speed.
  – Tests must be hand scored
Computerized Tests

- Concussion Vital Signs
- C3 Logix
- axon
- VistaLifeSciences
- ImPACT™
Computerized Tests Cont.

• **Advantages:**
  – Can be used in groups (Less costly)
  – Standardized administration
  – Immediate scoring/data capture
  – Finer assessment of RT/Proc Speed (altho other problems)
  – Multiple languages
  – Theoretically infinite alternate forms
• Disadvantages:
  – Less complete assessment of memory
  – Loss of observational data
  – Less control of effort/motivation
  – Diminished ability to assess understanding/track task performance
  – Over reliance on Visual Attention
  – Computer-specific measurement issues
  – Data loss
Hybrid Approaches

- Combine strengths of both P&P and Computerized tests
- Once adequate normative data have been established....
- Computer for baseline testing
- Computer plus P&P post-injury
The Hybrid Model:
Do ImPACT and P&P Measure the same thing?

N=114
<table>
<thead>
<tr>
<th>Exam Type</th>
<th>Post-Injury 1</th>
<th>Post-Injury 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Tested</td>
<td>10/06/2014</td>
<td>10/15/2014</td>
</tr>
<tr>
<td>Last Concussion</td>
<td>09/25/2014</td>
<td></td>
</tr>
<tr>
<td>Exam Language</td>
<td>English</td>
<td>English</td>
</tr>
<tr>
<td>Test Version</td>
<td>2.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Composite Scores</th>
<th>Percentile scores if available are listed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory composite (verbal)</td>
<td>79            36%   96        94%</td>
</tr>
<tr>
<td>Memory composite (visual)</td>
<td>95            98%   86        84%</td>
</tr>
<tr>
<td>Visual motor speed composite</td>
<td>36.98   56%   38.2      65%</td>
</tr>
<tr>
<td>Reaction time composite</td>
<td>0.82          2%    0.57     66%</td>
</tr>
<tr>
<td>Impulse control composite</td>
<td>4             2      2</td>
</tr>
<tr>
<td>Total Symptom Score</td>
<td>0             0      0</td>
</tr>
</tbody>
</table>

Cognitive Efficiency Index: -0.11 0.45
<table>
<thead>
<tr>
<th>Test</th>
<th>Date</th>
<th>Total Correct</th>
<th>Delayed Recall</th>
<th>% Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hopkins Verbal Learning Test</td>
<td>10/15/14</td>
<td>18 (-1.79)</td>
<td>4 (-2.48)</td>
<td>3.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>66.7%</td>
</tr>
<tr>
<td>Verbal Fluency</td>
<td></td>
<td>22 (1.26)</td>
<td></td>
<td>10.4%</td>
</tr>
<tr>
<td>PSU Cancellation</td>
<td></td>
<td>18</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Brief Visuospatial Memory Test</td>
<td></td>
<td>32</td>
<td>12</td>
<td>100%</td>
</tr>
<tr>
<td>Trail Making Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trails A – Time</td>
<td>13.38 (1.29)</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trails B – Time</td>
<td>30.91 (1.33)</td>
<td>90.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digit Span</td>
<td></td>
<td>8 (0.4)</td>
<td></td>
<td>65.5%</td>
</tr>
<tr>
<td>Symbol Search</td>
<td></td>
<td>43 (0.81)</td>
<td></td>
<td>79.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Value Added of Neuropsychological Testing
Hopkins Verbal Learning Test
Delayed Recall

<table>
<thead>
<tr>
<th>Test Intervals</th>
<th>Injured</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>2 Hour</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>48 Hour</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>1 Week</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>1 Month</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

Echemendia, et al., 2001
Unique Contribution of Neurocognitive Testing to Management of mTBI

Testing reveals cognitive deficits in asymptomatic athletes within 4 days post-concussion (ImPACT Battery)

\[ N=215, \text{ MANOVA p}<.000000 \]
(Fazio et al., Neurorehab, In Press)
"Value Added" of Neurocognitive Testing After Sports-Related Concussion

Neurocognitive testing increases Diagnostic yield to 93%

201 concussed High School and collegiate athletes tested with 2 days of injury. Abnormal performance determined by RCI’s (Van Kampen et al, AJSM ‘06)
### Value Added of Neuropsychological Testing
#### 1997-2004 Data

<table>
<thead>
<tr>
<th>NEUROPSYCH</th>
<th>SYMPTOMS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abnormal</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>Abnormal</td>
<td>116 (39%)</td>
<td>91 (30%)</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>32 (11%)</td>
<td>61 (20%)</td>
<td></td>
</tr>
</tbody>
</table>

N=300 from merged Physician and NP database
NP Meta Analysis – Effect Sizes

Iverson, Gagnon & Griesbach, 2012
Test administration is relatively routine and does not require extensive specialized knowledge.

The administration of selected NP tests may be delegated to paraprofessionals who have been trained by the NP and are supervised by the NP.

Interpretation of test data is complex and requires comprehensive knowledge of test theory, psychometric principles, statistics, individual test properties, the pathology being examined, etc.

Clinical NPs are uniquely trained and qualified to interpret NP tests. Failure to consult with NPs may lead to inaccurate interpretation of data and present a medico-legal quandary.
Thank you!