Conducting TBI Evaluations: Using Data from WAIS-IV, WMS-IV, and ACS for WAIS-IV and WMS-IV

Gloria Maccow, Ph.D., Assessment Training Consultant

Objectives

• Provide a brief description of WAIS-IV, WMS-IV, and ACS for WAIS-IV and WMS-IV.
• Use sample information to describe use of WAIS-IV, WMS-IV and ACS to answer a specific clinical question.

Three Batteries

• WAIS-IV, WMS-IV, and ACS were developed to be used together.
• Decisions made in the development of one instrument affected the development of other components.
• Each instrument provides unique information about the examinee.
Applications of Batteries

WAIS-IV and WMS-IV used for
- School based evaluations
- Disability evaluations
- Psychiatric evaluations
- Neuropsychological evaluations
- Forensic evaluations
- Medical/legal evaluations
- Competency evaluations
- Vocational Rehabilitation evaluations, etc.

Factors to Consider

- Difficult to build one instrument to answer all possible questions.
- Not all clinicians will need all pieces of information.
- Expectation is that clinicians will select those measures that best fit their practice and workflow.

Factors to Consider

- The tests were built together to allow users to better identify the nature of the underlying cognitive difficulty.
- One of the strengths of the tests is their co-norming.
- Use regression based approach to partial out overlapping variance (contrast scores).
What is the GAI?

- The WAIS-IV GAI provides the practitioner with a summary score that is less sensitive than the FSIQ to the influence of working memory and processing speed.
- GAI = sum of scaled scores for VCI subtests and PRI subtests
What is the GAI?

- WAIS-IV GAI should be used for discrepancy comparisons
  - Ability and Memory
  - Ability and achievement
- GAI is NOT a replacement for FSIQ

General Ability Index

Consider* using the GAI if a significant and unusual discrepancy exists between
- VCI and WMI; or
- PRI and PSI; or
- WMI and PSI, or
- between subtests within WMI and/or PSI.

Note: The FSIQ is the most valid measure of overall cognitive ability and WM and PS are vital to comprehensive evaluation of cognitive ability.

General Ability Index - Note!

- The GAI is used when neuropsychological deficits adversely impact performance on WM and PS.
- Impaired performance on WM and/or PS may mask actual differences between general cognitive ability (FSIQ) and other cognitive functions (e.g., memory).
- The GAI does not replace the FSIQ. Report and interpret GAI along with FSIQ.

[see WAIS-IV Technical Manual]
Memory and Learning

- Encoding: External information is transformed into mental representations or memories and stored in STM.
- Consolidation: Information from immediate memory is solidified into long-term memory stores.
- Retrieval: Information is brought into conscious awareness.

WMS-IV Test Battery

Seven subtests:

- Logical Memory, Verbal Paired Associates, and Visual Reproduction - retained from WMS-III.
- Brief Cognitive Status Exam, Designs, Spatial Addition, and Symbol Span - NEW.
WMS-IV Test Battery

Logical Memory, Verbal Paired Associates, Designs, and Visual Reproduction have two conditions: the immediate condition (I) and the delayed condition (II), which are administered about 20-30 minutes apart.

WMS-IV Batteries

Adult Battery Ages 16-69
Older Adult Battery Ages 65-90
[Also, WMS-IV Flexible Approach]

Types of Scores

- Primary Subtest Scaled Scores (mean=10, sd = 3)
- Index Scores (mean=100, sd = 15)
- Process Scores (Scaled Score or Cumulative Percentage)
- Contrast Scaled Scores
Primary Goal of ACS

To expand and enhance the clinical utility of WAIS-IV and/or WMS-IV through . . .
- Additional assessments, and
- Software.

Applications of ACS

additional assessments of:
- premorbid functioning
- effort
- social cognition
- executive function

A separate instrument, *Texas Functional Living Scale*, linked with the WAIS-IV and WMS-IV, can be used to assess daily living skills.

Applications of ACS

and software that delivers:
- Demographically Adjusted Norms
- Additional scores for WAIS-IV and WMS-IV
- Reliable Change scores
Premorbid Functioning

Test of Premorbid Functioning (TOPF)
- Revision of the Wechsler Test of Adult Reading (WTAR).
- Provides an estimate of premorbid intellectual functioning.

Test of Premorbid Functioning

- Uses Atypical Grapheme-Phoneme translation to measure word knowledge through reading.
- Relatively resistant to brain injury and dementia.

Test of Premorbid Functioning

- Premorbid Prediction Models
  - Demographics only (simple or complex)
  - TOPF only
  - Demographics with TOPF
- Predict WAIS-IV Indexes and WMS-IV IMI, DMI, and VWMI
Clinical Applications
Traumatic Brain Injury
Blake Sample23

Remember! Many Factors can Influence Performance
- Acuity
- Attention
- Executive Functioning
- Global Intellectual Functioning
- Working Memory
- Language Impairment (Auditory Memory subtests)
- Visual-Spatial Processing (Visual Memory subtests)
- Fatigue
- Poor Effort
- Impulsivity

Background Information
- Blake is a 23 year old, single, white male, with a bachelor’s degree in political science.
- He was working as an assistant store manager when he sustained a moderate TBI as a result of a motor vehicle accident.
- Upon admission to the hospital, his Glasgow Coma Scale was 7.
Background Information

- He sustained hemorrhagic contusions with depressed skull fracture in right frontal area.
- Blood was noted in anterior temporal tip.

Background Information

- Blake’s orientation and language functions returned to normal after 3-4 hours.
- He experienced on-going headaches, sleepiness, and fatigue for several days.
- He was released from the hospital after 3 days.

Background Information

- Blake continued to struggle with fatigue.
- He struggled to concentrate especially when reading.
- He returned to work after 3 weeks but had to leave early because of headaches and difficulty focusing and sustaining his attention.
Background Information

- His parents encouraged Blake to seek legal counsel regarding the accident because the accident had been caused by a car whose driver had failed to stop at the red light.
- The lawyer observed that they had a good chance of winning a claim against the company given the on-going difficulties Blake was experiencing after the accident.

Background Information

- As part of the legal case, Blake was sent for neuropsychological evaluation of ongoing attention problems.
- The evaluation was conducted 12 months post-injury.

Moderate TBI - Clinical Concepts

TBI associated with deficits in
- memory
- attention/executive functioning
- processing speed
- theory of mind and social perception (more recently)
Moderate TBI-Clinical Concepts

- Loss of cognitive functioning from a previous level.
- Impairments in attention and memory.
- Secondary gain introduced by the medical-legal case against the company responsible for the accident.
- Medical evidence for the presence of a moderate TBI.

TBI and WAIS-IV

<table>
<thead>
<tr>
<th>Composite</th>
<th>Clinical Mean</th>
<th>Control Mean</th>
<th>Mean Diff.</th>
<th>p value</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCI</td>
<td>92.1</td>
<td>100.8</td>
<td>8.73</td>
<td>.03</td>
<td>.52</td>
</tr>
<tr>
<td>PRI</td>
<td>86.1</td>
<td>100.7</td>
<td>14.64</td>
<td>&lt;.01</td>
<td>.94</td>
</tr>
<tr>
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<td>97.9</td>
<td>12.59</td>
<td>&lt;.01</td>
<td>.78</td>
</tr>
<tr>
<td>PSI</td>
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<td>97.6</td>
<td>17.09</td>
<td>&lt;.01</td>
<td>.97</td>
</tr>
<tr>
<td>FSIQ</td>
<td>83.9</td>
<td>99.4</td>
<td>15.50</td>
<td>&lt;.01</td>
<td>.93</td>
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</table>

n = 22

TBI and WMS-IV

<table>
<thead>
<tr>
<th>Index</th>
<th>Clinical Mean</th>
<th>Control Mean</th>
<th>Mean Diff.</th>
<th>p value</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMI</td>
<td>80.0</td>
<td>101.0</td>
<td>21.00</td>
<td>&lt;.01</td>
<td>1.25</td>
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<tr>
<td>VMI</td>
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<td>101.2</td>
<td>18.64</td>
<td>&lt;.01</td>
<td>1.07</td>
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<tr>
<td>VWMI</td>
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<td>104.6</td>
<td>19.06</td>
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<td>1.26</td>
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<td>IMI</td>
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<td>102.2</td>
<td>21.53</td>
<td>&lt;.01</td>
<td>1.24</td>
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<td>DMI</td>
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<td>100.4</td>
<td>22.64</td>
<td>&lt;.01</td>
<td>1.24</td>
</tr>
<tr>
<td>GAI</td>
<td>92.2</td>
<td>104.8</td>
<td>12.65</td>
<td>&lt;.01</td>
<td>.92</td>
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</table>

n = 32 (ages 19-45)
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Procedures Utilized
- WAIS-IV
- WMS-IV
- ACS: Demographically Adjusted Norms
- D-KEFS: Trail Making, Verbal Fluency
- ACS: Social Perception
- ACS: Suboptimal Effort

Moderate TBI and Cognition
- Is there evidence of impairment in general cognitive functioning?
- Is there evidence of a deficit in memory?

<table>
<thead>
<tr>
<th>Index/Subtest</th>
<th>Composite Score/Scaled Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing Speed</td>
<td>102</td>
</tr>
<tr>
<td>Working Memory</td>
<td>100</td>
</tr>
<tr>
<td>Information</td>
<td>12</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>13</td>
</tr>
<tr>
<td>Similarities</td>
<td>13</td>
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<tr>
<td>Verbal Comprehension</td>
<td>114</td>
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<table>
<thead>
<tr>
<th>Index/Subtest</th>
<th>Composite Score/Scaled Score</th>
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</thead>
<tbody>
<tr>
<td>Arithmetic</td>
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</tr>
<tr>
<td>Digit Span</td>
<td>10</td>
</tr>
<tr>
<td>Full Scale IQ</td>
<td>105</td>
</tr>
<tr>
<td>General Ability Index</td>
<td>106</td>
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</table>

WAIS-IV Scores
Index-Level Discrepancy Comparisons

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Difference</th>
<th>Critical Value</th>
<th>Significant Difference</th>
<th>Base Rate Overall Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCI - PRI</td>
<td>114</td>
<td>98</td>
<td>16</td>
<td>9.29</td>
<td>Y</td>
<td>12.2</td>
</tr>
<tr>
<td>VCI - WMI</td>
<td>114</td>
<td>100</td>
<td>14</td>
<td>10.18</td>
<td>Y</td>
<td>14.1</td>
</tr>
<tr>
<td>VCI - PSI</td>
<td>114</td>
<td>102</td>
<td>12</td>
<td>10.99</td>
<td>Y</td>
<td>22.2</td>
</tr>
<tr>
<td>PRI - WMI</td>
<td>98</td>
<td>100</td>
<td>-2</td>
<td>10.99</td>
<td>N</td>
<td>--</td>
</tr>
<tr>
<td>PRI - PSI</td>
<td>98</td>
<td>102</td>
<td>-4</td>
<td>11.75</td>
<td>N</td>
<td>--</td>
</tr>
<tr>
<td>WMI - PSI</td>
<td>100</td>
<td>102</td>
<td>-2</td>
<td>12.46</td>
<td>N</td>
<td>--</td>
</tr>
<tr>
<td>FSIQ - GAI</td>
<td>105</td>
<td>106</td>
<td>-1</td>
<td>3.5</td>
<td>N</td>
<td>--</td>
</tr>
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</table>

Moderate TBI and Ability

- On WAIS-IV, FSIQ and GAI within Average range.
- Verbal comprehension is a strength relative to perceptual reasoning, working memory, and processing speed.

WMS-IV Scores

<table>
<thead>
<tr>
<th>Index/Subtest</th>
<th>Index Score/Scaled Score</th>
<th>Index/Subtest</th>
<th>Index Score/Scaled Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory Memory</td>
<td>105</td>
<td>Visual Memory</td>
<td>96</td>
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<tr>
<td>Logical Memory I</td>
<td>13</td>
<td>Visual Reproduction</td>
<td>10</td>
</tr>
<tr>
<td>Logical Memory II</td>
<td>16(S)</td>
<td>Visual Reproduction II</td>
<td>10</td>
</tr>
<tr>
<td>Verbal Paired Associates I</td>
<td>7(W)</td>
<td>Designs I</td>
<td>10</td>
</tr>
<tr>
<td>Verbal Paired Associates II</td>
<td>8(W)</td>
<td>Design II</td>
<td>10</td>
</tr>
<tr>
<td>Visual Working Memory</td>
<td>100</td>
<td>Spatial Addition</td>
<td>12</td>
</tr>
<tr>
<td>Symbol Span</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Moderate TBI and Memory**

- On WMS-IV, all index scores are in the average range.
- Delayed memory is a strength relative to Immediate Memory (contrast scaled score = 14).
- Scores on memory indexes are average relative to general ability.
- Note relative weakness for VPA I and VPA II and relative strength for LM II.

**Ability-Memory Analysis**

<table>
<thead>
<tr>
<th>Index</th>
<th>Predicted WMS-IV Index Score</th>
<th>Actual WMS-IV Index Score</th>
<th>Diff.</th>
<th>Critical Value</th>
<th>Sign. Diff. Y / N</th>
<th>Base Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMI</td>
<td>103</td>
<td>105</td>
<td>-2</td>
<td>9.35</td>
<td>N</td>
<td>--</td>
</tr>
<tr>
<td>VMI</td>
<td>104</td>
<td>96</td>
<td>8</td>
<td>8.95</td>
<td>N</td>
<td>--</td>
</tr>
<tr>
<td>VMII</td>
<td>104</td>
<td>100</td>
<td>4</td>
<td>10.61</td>
<td>N</td>
<td>--</td>
</tr>
<tr>
<td>IMI</td>
<td>104</td>
<td>96</td>
<td>8</td>
<td>9.78</td>
<td>N</td>
<td>--</td>
</tr>
<tr>
<td>OMI</td>
<td>103</td>
<td>107</td>
<td>-4</td>
<td>9.57</td>
<td>N</td>
<td>--</td>
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</tbody>
</table>
Moderate TBI

- Is this profile atypical for Blake’s education level?
- Is there evidence for loss of cognitive functioning.

Use Demographically Adjusted Norms

Demographically Adjusted Norms

- Enable clinician to refine hypothesis about the degree to which a specific score is unexpected when compared to individuals of similar background characteristics (e.g., education level).
- Norms approximate the unique demographic subgroup of an individual.

Demographically Adjusted Norms

Available for WAIS-IV and WMS-IV subtest and index scores.
- Education-only adjusted t-scores.
- Full Demographically adjusted t-scores.
Use of Demographically Adjusted Norms

- Meant to minimize the impact of psychosocial variables on the diagnosis of cognitive impairment, such as estimating the degree of cognitive impairment after a brain injury or insult.
- “... most appropriately applied in the context of a neuro-diagnostic assessment.”

---

**WAIS-IV DAN**

<table>
<thead>
<tr>
<th>WAIS-IV Education Adjusted Composite Score Summary</th>
<th>Age Adjusted</th>
<th>Education Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite</td>
<td>Composite Score</td>
<td>Percentile Rank</td>
</tr>
<tr>
<td>VCI</td>
<td>114</td>
<td>82</td>
</tr>
<tr>
<td>PRI</td>
<td>98</td>
<td>45</td>
</tr>
<tr>
<td>WMI</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>PSI</td>
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<td>55</td>
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<tr>
<td>FSI Q</td>
<td>105</td>
<td>63</td>
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<tr>
<td>GAI</td>
<td>106</td>
<td>66</td>
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**WAIS-IV DAN**

<table>
<thead>
<tr>
<th>WAIS-IV Demographically-Adjusted Composite Score Comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison</td>
</tr>
<tr>
<td>VCI-PRI</td>
</tr>
<tr>
<td>VCI-WMI</td>
</tr>
<tr>
<td>GAI-VCI</td>
</tr>
<tr>
<td>GAI-PRI</td>
</tr>
</tbody>
</table>
### WMS-IV DAN

#### WMS-IV Education Adjusted Index Score Summary

<table>
<thead>
<tr>
<th>Index</th>
<th>t Score</th>
<th>Percentile</th>
<th>Qualitative Description</th>
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<tbody>
<tr>
<td>AMI</td>
<td>105</td>
<td>63</td>
<td>52</td>
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<tr>
<td>VMI</td>
<td>96</td>
<td>39</td>
<td>45</td>
</tr>
<tr>
<td>VVMI</td>
<td>100</td>
<td>50</td>
<td>47</td>
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<tr>
<td>IMI</td>
<td>96</td>
<td>39</td>
<td>44</td>
</tr>
<tr>
<td>DMI</td>
<td>107</td>
<td>68</td>
<td>52</td>
</tr>
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</table>

### WMS-IV DAN

#### WMS-IV Demographically-Adjusted Index Score Comparisons

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Diff.</th>
<th>Critical Value</th>
<th>Sign. Diff.</th>
<th>Directional Base Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMI-VMI</td>
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<td>45</td>
<td>7</td>
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<td>--</td>
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<tr>
<td>IMI-DMI</td>
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<td>52</td>
<td>-8</td>
<td>6.21</td>
<td>Y</td>
<td>8.3%</td>
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### Table 5.27. Diagnostic Statistics for Traumatic Brain Injury vs. Matched Control Groups for Education-Adjusted WAIS-IV and WMS-IV Composite Scores

<table>
<thead>
<tr>
<th>Cut Score</th>
<th>2 or more</th>
<th>3 or more</th>
<th>4 or more</th>
<th>5 or more</th>
<th>6 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 or less</td>
<td>0.78</td>
<td>0.72</td>
<td>0.66</td>
<td>0.59</td>
<td>0.53</td>
</tr>
<tr>
<td>35 or less</td>
<td>0.66</td>
<td>0.56</td>
<td>0.56</td>
<td>0.50</td>
<td>0.44</td>
</tr>
<tr>
<td>30 or less</td>
<td>0.50</td>
<td>0.47</td>
<td>0.41</td>
<td>0.22</td>
<td>0.13</td>
</tr>
</tbody>
</table>
Table 5.27. Diagnostic Statistics for Traumatic Brain Injury vs. Matched Control Groups for Education-Adjusted WAIS-IV and WMS-IV Composite Scores

<table>
<thead>
<tr>
<th>Cut Score</th>
<th>2 or more</th>
<th>3 or more</th>
<th>4 or more</th>
<th>5 or more</th>
<th>6 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 or less</td>
<td>0.69</td>
<td>0.72</td>
<td>0.78</td>
<td>0.88</td>
<td>0.97</td>
</tr>
<tr>
<td>35 or less</td>
<td>0.81</td>
<td>0.91</td>
<td>0.94</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>30 or less</td>
<td>0.94</td>
<td>0.97</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Moderate TBI - Executive Functioning

Are there deficits in executive functioning?
- Trail Making: low-average scores for number sequencing and switching.
- Cannot determine if the problem is executive functioning or slow processing speed.
- Verbal Fluency: scores in the average range.

Trail Making

D-KEFS Trail Making
- Visual Scanning SS = 10
- Number Sequencing SS = 7
- Letter Sequencing SS = 8
- Number-Letter Switching SS = 6
- Number-Letter Switching Errors SS = 10
- Motor Planning SS = 9
Verbal Fluency

D-KEFS Verbal Fluency
- Letter Fluency SS = 11
- Category Fluency SS = 9
- Category Switching SS = 8
- Category Switching Accuracy SS = 8
- Set Loss Error SS = 10
- Repetitions SS = 9

Moderate TBI - Social Perception

Is there a deficit in social perception?
- Scores range from low average to average with 3 of 4 scores at 1sd below mean.
- Compared to intellectual functioning, social perception scores were low average.
- Observationally, he made errors mostly on incongruent items, particularly sarcasm.

Social Perception

Social Perception has 3 tasks:
- Affect Naming (Happy, Sad, Angry, Surprise, Disgust, Fear, and Neutral)
- Prosody-Face Matching (includes Sarcasm)
- Prosody-Pairs Matching
Symptom Exaggeration?

- What if the test results were exaggerated in order to gain an advantage in the law suit?
- Use ACS effort assessment to help determine if suboptimal effort issues should be considered.

Suboptimal Effort

Criteria for definite malingering, neuro-cognitive deficit:
- Presence of substantial external incentive,
- Definitive negative response bias, and
- The response bias is not accounted for by psychiatric, neurological, or developmental factors (Slick, Sherman, and Iverson, 1999).

Assessing Suboptimal Effort

- ACS Word Choice
- WAIS-IV Reliable Digit Span
- WMS-IV
  - Logical Memory Delayed Recognition
  - Verbal Paired Associates Delayed Recognition
  - Visual Reproduction Delayed Recognition

[Available for ages 16-69]
Word Choice

1. Examinee sees and hears 50 words in succession.
2. Examinee identifies each word as either man-made or natural.
3. Examinee sees card with 50 pairs of words and selects word that was previously presented from each pair.

Suboptimal Effort

- Use at least 3 indicators.
- Require at least 2 indicators at or below cut-off when using low cut-offs (e.g. 10%).

See Effort Assessment Score Report Blake Sample 23.

Moderate TBI - Conclusions

- Is this protocol indicative of suboptimal effort? No
- Overall conclusions
  - Blake suffered a moderate/severe TBI as documented by medical records.
  - Relative to his verbal comprehension abilities, he demonstrated a weakness on measures of perceptual reasoning, working memory, and processing speed.
Moderate TBI - Conclusions

- Overall conclusions
  - His memory abilities are average compared to his general ability.
  - Interpretation of Blake's performance on the Auditory Memory index should account for the variability of the subtest scores.

AMI - Score Variability

The clinical relevance of the score variability on the AMI should be addressed in terms of Blake's
- premorbid abilities,
- demands in his current environment,
- other co-occurring physical factors (e.g., recent onset of auditory acuity difficulties or physical impairments), or
- emotional status (e.g., depression, anxiety).

Moderate - TBI Conclusions

Overall conclusions
- He demonstrated weaknesses in switching mental set and social perception.
- These characteristics are consistent with known effects of brain injury.
Recommendations

- It may be necessary to give Blake very specific routines for work completion. For example, he should be told where to put materials, what to do if he does not understand the assignment, and what to do with the assignment once complete.
- Blake should be set well-defined time limits for task completion, so that tasks are completed in a timely manner. Blake should be allowed to monitor his own progress with a timing device.

Recommendations

- Blake should be taught to use a problem-solving approach to behavioral situations. Steps should involve Blake determining the best possible option for his behavior, choosing a problem-solving strategy, and evaluating the outcome.
- Concrete examples should be used to teach the approach (e.g., “What should you do if you are trying to concentrate on your work and another person begins talking to you?”).