Neuropsychological Correlates of Early Impaired Self-Awareness Following TBI

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Acknowledgements

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Impaired Self-Awareness

- *Anosognosia* is a condition in which a person who suffers disability due to brain injury is unaware of the extent or existence of their disability

- Associated with:
  - Poor compliance in rehab
  - Poor long-term outcome
  - More pronounced for cognitive and behavioral impairments

- Few studies of early ISA

- Patients overestimate abilities 1st 6 months postinjury

- Improvement in ISA from 1 to 3 years postinjury
Impaired Self-Awareness

- Previous studies report inconsistent results
- Better awareness & better cognitive performance
- No strong relation
- Mixed findings correlating EF and ISA
  - O’Keefe (2004): recognizing and processing errors
  - Hart et al. (2005): WM, verbal fluency
  - Bivona et al. (2008): problem solving, mental flexibility, response inhibition
  - No relation: (Bach & David 2006)
Hypotheses

1) Degree of early ISA will be correlated with the degree of episodic memory dysfunction (↓ awareness related to ↓ memory)

2) Degree of early ISA will be correlated with the degree of executive dysfunction (↓ awareness related to ↓ EF)

3) Early ISA will be correlated more robustly with measures of memory and EF than other domains (e.g., language, visual attention)

- **Memory**—maintain and update perception of abilities from recent experiences
- **EF**—integrating and synthesizing information across time and shifting between objective to subjective views of self
Methods

- **Participants**
  - Participants recruited from Philadelphia and Jackson, MS
  - Documented moderate to severe TBI (included c-milds)
  - Admission to Level-I trauma care < 24 hours postinjury
  - Inpatient rehab admission < 72 hours post acute D/C
  - Age 16 +
  - Emergence from PTA prior to rehab D/C
  - Fluent in English
  - No pre-injury neurological D/O
  - Non-aphasic
Methods

- Demographics obtained through interview
- GCS, DOI, DOT, PTA duration, and TFC obtained through medical record review
- Informed consent compliant with Declaration of Helsinki
Methods

- Neuropsych assessments performed after PTA resolution
- Assessment of ISA contemporaneous with neuropsych by patient and clinician independently
- ISA assessment completed by treating neuropsychologist
Measures

Awareness Questionnaire (Sherer, et al., 1998)

- 17-item interview rating Cognitive (7), Behavioral/Affective (6), and Motor/Sensory (4) domains
- Compares preinjury to current functioning
  - “How is your ability to ____ as compared with before your injury?”
  - 1—much worse to 5—much better
- Parallel version given to clinicians and/or family members
- The degree of ISA is the discrepancy score: Patient – Clinician ratings
- Higher discrepancy scores indicate poorer self-awareness
Measures

Episodic Memory
- Logical Memory (WMS-R)
- Rey Auditory Verbal Learning Test (RAVLT)

Executive Function
- Wisconsin Card Sorting Test (WCST)
- Modified Six Elements Test (M-SET)
- Dual Task Procedure

Visual Attention
- Trail Making Test (TMT A & B)

Language
- Controlled Oral Word Association Test (COWAT)

Functional Status
- FIM™ at rehabilitation admission
Measures

**M-SET**
- Behavioural Assessment of the Dysexecutive Syndrome (BADS)
- 3 tasks: dictation, arithmetic, picture naming
- Each task divided into 2 parts (A & B)
- Attempt some of each of the 6 tasks in 10 minutes
- Cannot perform similar subtests consecutively

**Scores**
- Tasks attempted/completed
- Broken rules
- Overall performance profile
- Max time spent on single task
Measures

Dual Task Procedure (Della Sala, Baddeley, Papagno, and Spinnler, 1995)

- Repeating digit strings at participant’s maximum span
- Crossing out boxes connected by paths of lines
- Both tasks performed simultaneously for 2 min.

Scores (under the dual task condition)

- Tracking
- Forward Digit Span
### Demographic and Injury Variables (n=165)

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<th>Categorical Variables</th>
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<th>(%)</th>
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<tr>
<td>Female</td>
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<td>3 - 8</td>
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<table>
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<td>Education (years)</td>
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<td>Duration of PTA (days)</td>
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<td>TFC (days)</td>
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<td>Chronicity (DOI-DOT, days)</td>
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<td>(0)</td>
<td>36 (23, 57)</td>
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<td>FIM™ at Rehab Admission</td>
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<td>(5.5)</td>
<td>52 (38, 71)</td>
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# Neuropsychological Measures

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<tr>
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<tr>
<td>WMS-R Logical Memory</td>
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<tr>
<td>RAVLT</td>
<td>7</td>
<td>(4.2)</td>
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<td>WCST</td>
<td>16</td>
<td>(9.7)</td>
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<tr>
<td>M-SET</td>
<td>17</td>
<td>(10.3)</td>
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<td>Dual Task</td>
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<td>(9.7)</td>
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<tr>
<td>TMT (A &amp; B)</td>
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<td>(7.9)</td>
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<tr>
<td>COWAT</td>
<td>0</td>
<td>(0)</td>
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Missing Data

- Imputation as previously reported (Sherer, et al., 2003)
- Neuropsych data imputed using individual predictive models using other predictor variables (e.g., age, gender, GCS, TFC, etc.)
- 2 AQ clinician ratings missing 1 item
- 1 AQ patient rating missing 1 item
  - Imputed with median of completed items from relevant subscale
Results

- 133 TBIMS participants were recruited
  - 11 did not meet inclusion criteria for this study
- 58 non-TBIMS participants who also met study criteria were included
  - 15 declined to participate
- TBIMS and non-TBIMS groups differed only for chronicity ($p < .002$, mean diff. 19.7 days)
- Chronicity correlated with the AQ P-C discrepancy score ($p < .04$) and was included as a covariate in analyses
Principal Components Analysis

- Orthomax rotation for orthogonal structure (*same solution when using oblique rotation*)
- Item loadings $> .41$ were considered significant based on sample size for $\alpha = .01$ (*Stevens, 2002*)
- 4 factors emerged with Eigenvalues $> 1$
Total variance = 68.1%  

<table>
<thead>
<tr>
<th></th>
<th>I Memory</th>
<th>II Strategic Multitasking</th>
<th>III Alternating Attention</th>
<th>IV Concept Formation</th>
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<tr>
<td>WMS-R LM Del. Recall</td>
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<td>WMS-R LM Imm. Recall</td>
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<td>RAVLT Trials 1-5 (sum)</td>
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<td>RAVLT Del. Recall</td>
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<td>M-SET # Tasks Completed</td>
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<td>M-SET Profile</td>
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<td>M-SET # Broken Rules</td>
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<td>Dual Task–Digit Span</td>
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<td>WCST Persev. Responses</td>
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<td>WCST # Categories</td>
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*COWAT did not load significantly on any factor*
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<tr>
<th>Factors</th>
<th>Total Score</th>
<th>Cognitive</th>
<th>Behavioral/Affective</th>
<th>Motor/Sensory</th>
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<td>-.33</td>
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<td>III – Alternating Attention</td>
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<td>.07</td>
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<td>IV – Concept Formation</td>
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*Spearman ρ correlations*

*Bonferroni correction  p < .0042*
Predicting Early ISA

- Explored whether neuropsych variables could predict early ISA (AQ P-C discrepancy score)
- Linear regression model
  - Demographics (age, gender, education)
  - Injury-related variables (GCS, TFC, chronicity)
  - Functional status (rehab admission FIM™)
  - Neuropsychological PCA factor scores
# Predicting Early ISA

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<thead>
<tr>
<th>Variable</th>
<th>$df$</th>
<th>$\beta$</th>
<th>SE $\beta$</th>
<th>$t$</th>
<th>$p$</th>
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<td>Age*</td>
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<tr>
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<td>2.5</td>
<td>1.01</td>
<td>.32</td>
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<td>Education*</td>
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<td>.16</td>
<td>.55</td>
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<td>.77</td>
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<td>.02</td>
<td>.05</td>
<td>.45</td>
<td>.65</td>
<td>.04</td>
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<td>GCS</td>
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<td>-.88</td>
<td>.38</td>
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<td>TFC</td>
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<td>-.01</td>
<td>.09</td>
<td>-.15</td>
<td>.88</td>
<td>-.02</td>
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<tr>
<td>FIM™ (Rehab Admit)*</td>
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<td>-.07</td>
<td>.07</td>
<td>-1.0</td>
<td>.32</td>
<td>-.09</td>
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<td><strong>Factor I (Memory)</strong></td>
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<td>-.14</td>
<td>.05</td>
<td><strong>-2.85</strong></td>
<td>&lt; .005</td>
<td>-.24</td>
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<td><strong>Factor II (Multitasking)</strong></td>
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<td>-.18</td>
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<td>.01</td>
<td>-.23</td>
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<td>.03</td>
<td>.03</td>
<td>1.01</td>
<td>.31</td>
<td>.08</td>
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</table>

*Restricted cubic spline with 3 knots used
Higher factor scores predict less impaired self-awareness
Predicting Early ISA

- 20.7% variability account ($adj. R^2 = .15$)
- 2 factors were sig. after accounting for other demographic and injury predictors

- Injury severity indices and age were not sig. predictors
  - Neuropsych test performance sensitive to these effects
Discussion

- **Hypothesis 1**—supported
- Early ISA was correlated with episodic memory dysfunction (↓ awareness related to ↓ memory)

- Difficulty recalling previous failures and feedback about deficits contribute to early ISA
- Interventions to improve memory and self-monitoring may improve awareness
Discussion

- **Hypothesis 2**—partially supported

- Early ISA was correlated with executive dysfunction (↓ awareness related to ↓ EF)

- Early ISA was correlated more robustly with some measures of EF

- ISA not sig. related to WCST results

- M-SET is a more complex task of EF and therefore may correlate more robustly with ISA
Discussion

- **Hypothesis 3**—supported
- Early ISA will be correlated more robustly with measures of memory and EF than other domains
  - COWAT and TMT B also considered tests of EF
  - Clearly more related to episodic memory and *some* facets of EF
  - Results may be due in part to specific EF measures included (e.g., common-method variance)
Conclusion

- Episodic memory and EF important contributors to early ISA
- Support the concept of self-monitoring and updating schema of patient’s abilities to facilitate accurate self-awareness