Neuropsychological Correlates of Early Impaired Self-Awareness Following TBI

Stephen R. McCauley, PhD
Baylor College of Medicine
Houston, USA

TIRR MEMORIAL HERMANN
Rehabilitation & Research

BCM
Baylor College of Medicine

Acknowledgements

Mark Sherer, PhD

- (TIRR/Memorial Hermann and BCM, Houston, TX)

Tessa Hart, PhD

- (Moss Rehabilitation Research Institute, Philadelphia, PA)

Marie-Claude Roberge, PhD

- (TIRR/Memorial Hermann, Houston, TX)

TBI Model Systems Project

- Funding: NIDRR (H133A980067, H133A980035, H133A97033)

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
  - Anderson & Tranel (1989), Boake (1995), O'Keefe et al (2007)
- No strong relation
  - McKinlay & Brooks (1984), Prigatano & Altman (1990), Newman et al. (2000).
- 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)

Categorical Variables	**Missing**	**(%)**	***n***	**(%)**
Gender	0	(0)		
Male			127	(77.0)
Female			38	(23.0)
GCS	6	(3.6)		
3 - 8			97	(58.8)
9 - 12			28	(17.0)
13 - 15			34	(20.6)
Continuous Variables	**Missing**	**(%)**	**Median** (25^{th}, 75^{th} %iles)	
Age (years)	0	(0)	32 (22, 44)	
Education (years)	0	(0)	12 (11, 14)	
Duration of PTA (days)	43	(26.1)	29 (13, 45)	
TFC (days)	5	(3)	4 (1, 14)	
Chronicity (DOI-DOT, days)	0	(0)	36 (23, 57)	
FIM™ at Rehab Admission	9	(5.5)	52 (38, 71)	

Neuropsychological Measures

Measure	Missing	(%)
WMS-R Logical Memory	1	(0.6)
RAVLT	7	(4.2)
WCST	16	(9.7)
M-SET	17	(10.3)
Dual Task	16	(9.7)
TMT (A & B)	13	(7.9)
COWAT	0	(0)

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

Results

Principal Components Analysis

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

Total variance = 68.1%	I Memory	II Strategic Multitasking	III Alternating Attention	IV Concept Formation
WMS-R LM Del. Recall	**.89**			
WMS-R LM Imm. Recall	**.87**			
RAVLT Trials 1-5 (sum)	**.82**			
RAVLT Del. Recall	**.75**			
M-SET # Tasks Completed		**.90**		
M-SET Profile		**.89**		
M-SET # Broken Rules		**-.58**		
TMT B			**.77**	
TMT A			**.77**	
Dual Task–Tracking			**-.48**	
Dual Task–Digit Span			**-.75**	
WCST Persev. Responses				**.94**
WCST # Categories				**-.83**

COWAT did not load significantly on any factor

AQ and Factor Correlations

	Awareness Questionnaire (P-C discrep.)			
Factors	**Total Score**	**Cognitive**	**Behavioral/ Affective**	**Motor/ Sensory**
I – Memory	**-.35 < .0001**	**-.35 < .0001**	**-.33 < .0001**	-.15 *ns*
II – Strategic Multitasking	**-.30 < .0001**	**-.31 < .0001**	**-.25 .001**	**-.23 .003**
III – Alternating Attention	.08 *ns*	.07 *ns*	.07 *ns*	-.01 *ns*
IV – Concept Formation	.13 *ns*	.16 *ns*	.08 *ns*	.09 *ns*

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

Variable	*df*	β	SE β	*t*	*p*	Stnd β
Age*	2	-.10	.07	-1.48	.14	-.13
Gender	1	2.28	2.5	1.01	.32	.08
Education*	2	.16	.55	.29	.77	.02
Chronicity*	2	.02	.05	.45	.65	.04
GCS	1	-.25	.28	-.88	.38	-.08
TFC	1	-.01	.09	-.15	.88	-.02
FIM™ (Rehab Admit)*	2	-.07	.07	-1.0	.32	-.09
Factor I (Memory)	1	-.14	.05	**-2.85**	**< .005**	-.24
Factor II (Multitasking)	1	-.86	.41	**-2.09**	**< .04**	-.18
Factor III (Alt. Attn.)	1	-.002	.01	-.23	.82	-.02
Factor IV (Concept Form.)	1	.03	.03	1.01	.31	.08

**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