Mild Traumatic Brain Injury in Military Veterans: Clinical Implications for Assessment & Treatment

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High Cognitive Demands of College

Today’s discussion will largely focus on this growing group of military veterans

2.6 million deployed to Iraq and Afghanistan over the past 17+ years

1.7 million have left military service and another quarter of a million more per year will do so over the next few years

The majority enter college after separation from service

Number of student veterans has increased drastically on a national level

In 2009 there were approximately 500,000 and in 2013 there were over 1 million

The number of military affiliated students at ASU are rising

National Center for Education Statistics, 2016
Who are Student Veterans?

- Mostly male
- Females are over represented
- Older
- Almost half have children
- Almost half are married
- Over 60% are first in their families to go to college

There are unique challenges in this population.
There is disagreement about academic success in military veteran college students

Student Veterans of America: 72% academic success among veterans (2017)

Only 51% of veterans graduate vs. 59% of non-veterans (National Center for Education Statistics, 2013)

There is an 88% attenuation rate (Briggs, 2012)
## Service-Related Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Veterans</th>
<th>Civilians</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBI (mTBI)</td>
<td>20 - 33%</td>
<td>~8% (adult)</td>
</tr>
<tr>
<td>PTS</td>
<td>14 - 44%</td>
<td>6.8%</td>
</tr>
<tr>
<td>Depression</td>
<td>14%</td>
<td>6.7%</td>
</tr>
<tr>
<td>Anxiety Disorders</td>
<td>??</td>
<td>18% yearly</td>
</tr>
<tr>
<td>PTS within mTBI</td>
<td>33 – 39%</td>
<td>??</td>
</tr>
</tbody>
</table>

1) Defense and Brain Injury Center, 2015; 2) U.S. Department of Veterans Affairs; Dolan et al., 2012; 3) National Alliance on Mental Illness; 4) Lew et al., 2010; 5) CDC; 6) U.S. Department of Veterans Affairs; 7) Anxiety and Depression Association of America; 8) Lew et al., 2010
Table 1. Self-Reported Rates of Depression, PTSD, and mTBI in the Veteran and Civilian Groups

<table>
<thead>
<tr>
<th>Condition</th>
<th>Veterans (N=138)</th>
<th>Civilians (N=213)</th>
<th>Group Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>24.3%</td>
<td>15.0%</td>
<td>$\chi^2=4.38$, $p=.036^*$</td>
</tr>
<tr>
<td>PTSD</td>
<td>11.6%</td>
<td>1.4%</td>
<td>$\chi^2=17.00$, $&lt;.001^{**}$</td>
</tr>
<tr>
<td>mTBI (Diagnosed or Suspected)</td>
<td>25.4%</td>
<td>24.9%</td>
<td>$\chi^2&lt;1$</td>
</tr>
<tr>
<td>mTBI Group Only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mTBI + Depression</td>
<td>31.4%</td>
<td>9.4%</td>
<td>$\chi^2=6.86$, $p=.009^{**}$</td>
</tr>
<tr>
<td>mTBI + PTSD</td>
<td>28.6%</td>
<td>0.0%</td>
<td>$\chi^2=17.08$, $p&lt;.001^{**}$</td>
</tr>
</tbody>
</table>
Challenges in Assessment and Treatment of Cognitive Symptoms Related to mTBI in Military Veterans

- Military Culture
- Injury Environment
- Transition
- Other Conditions
“And this one is for making certain military culture stays the same, forever.”
Military Culture

Defined by a unique vocabulary, rules, and belief systems (Reger et al., 2007)

Attitude that seeking healthcare services is an indication of weakness

Barrier to care
Injury Environment
Combat
- Loss of life and limb
- Delay the mission
- Delay discharge/return home

Training
- “Recycled”
- Failure

Barrier to care
Transition
Transition

Military-to-Civilian Transition can create stress and anxiety

Identity

Civilian-military divide

Moral Injury

Stereotypes

Barrier to care

Commonly Reported Overlapping Symptoms

<table>
<thead>
<tr>
<th>Condition</th>
<th>Memory</th>
<th>Attention</th>
<th>Sleep</th>
<th>Anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td>mTBI</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>PTS</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Depression</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Overlapping symptoms of depression, anxiety and PTS and the frequent concomitance with mTBI, provides one of the largest hurdles in assessment of unremitting mTBI symptoms (Karr et al., 2014; Lange et al., 2012)
Delay in Reporting
Absence of Reporting
Misdiagnosis

Military Culture
Injury Environment
Transition
Other Conditions
Questions & Discussion

- Military Culture
- Injury Environment
- Transition
- Other Conditions
Long-term Cognitive Symptoms related to mTBI in Military Veterans

Symptoms present more than a year after injury

• Memory
• Attention
• Executive Function
• Speed of Processing
“...in contrast to the prevailing view that most symptoms of concussion are resolved within 3 months post injury, approximately half of individuals with a single mTBI demonstrate long-term cognitive impairment.”
Assessment of Unremitting mTBI Symptoms

Despite subjective reports of long-term symptoms related to mTBI in military veterans... (Hartikainen et al., 2010; Schneiderman et al., 2008)

No long-term neuropsychological deficits associated with mTBI (Storzbach et al., 2015)

Concomitant PTSD or Depression account for the deficits (Lang et al., 2012; Seal, 2016; Verfaellie et al., 2014)

Symptom report related to mTBI is often dismissed due to lack of neuropsychological test evidence (Spencer et al., 2010; Verfaellie et al., 2014)

Based on commonly used clinical neuropsychological assessments
Why don’t standardized assessments consistently capture subtle deficits related to chronic mTBI?

• Tests were not designed to measure chronic cognitive deficits related to mTBI
• Standardized to elicit the best possible performance
• Do not reflect real-world demands that may exacerbate “subtle” deficits
• Performance may only be affected when the task is challenging and placing more demands on the cognitive system (Cicerone, 2009)
Measuring Memory

Digit Span
• Forward
• Backward

Word Lists
• AVLT
• Paired Associates

For the most part, these are decontextualized rote memory tasks that don’t reflect real-world demands.
Our studies have included traditional clinical tasks, experimental tasks and **self-report of symptoms**

- Rote memory
- Episodic memory tasks
- Working memory
- Executive function
- Decision making
- Attention
Online Questionnaire

- Completed at home
- 107 questions
- Demographic information
- Military, Medical, and Educational Background
VETERANS WITH mTBI: Utilizing Self-Report Information

Krug & Turkstra (2015)
VETERANS WITH mTBI:
Asking the Right Questions

Comprehensive survey as part of the assessment

*Military Service*

*Circumstances*

*Situational Checklist*

Self-assessment and rating

Memory

Attention

Anxiety
Self-Assessment and Rating

- Beck Depression Inventory
- Beck Anxiety Inventory
- Informal Memory and Attention Ratings

“Compared to other people my age, my OVERALL memory is:
5 = much better
4 = slightly better
3 = the same
2 = slightly worse
1 = far worse”
History of Military Service

• Enlistment length
• Military Occupation
• Deployment

This information can lead to more specific questions and can direct your assessment and referral decisions
Diagnosed and Suspected Head Injuries

Description of Circumstances

Who diagnosed the injury?
What caused the injury?
Where did the injury happen?
Suspected TBI?

Symptoms

Immediately experienced
Still experiencing

Mayo Classification System for Traumatic Brain Injury Severity (Malec et al., 2008)
In-Person Testing

At ASU

• Approximately 2 to 2 ½ hours

• Mostly computerized tasks
Commonly Used Neuropsychological Tasks

- Digit Span
- Trail Making

Performance on these tasks were not related to mTBI or PTSD

Did provide evidence of effort
Digit Span as a Measure of Effort

Reliable Digit Span Score (RDS): combining the highest span set where both trials were accurately recalled in both the forward and backward condition

An RDS of $\leq 7$ is considered evidence of lack of effort

In my study no participant earned an RDS below 10

1) Heinely et al., 2005; Loring, Goldstein, Chen, Drane, Lah, Zhao, & Larrabee, 2016
2) Schroeder, Twumasi-Ankrah, Baade, & Marshall, 2012
Documenting Reported Deficits

We need ecologically valid, complex tasks that:

• Shift from simple memory tasks
• Tasks should mirror real-world demands
• Tasks should tap higher-order cognitive processes
Memory in Real Life

• Stories
• Lectures
• Conversations
• Events

This type of memory is complex, requiring sequencing and recall of semantic information
Narrative Recall Tasks

**Logical Memory I (Immediate)**

Participants were told two stories. After each story, the participant was asked to retell the story “in as much detail and using as many of the same words as possible.”

**Logical Memory II (Delayed)**

After a 20-30 minute delay, the participant was asked to retell each story.

## Study Participants

<table>
<thead>
<tr>
<th></th>
<th>Control Group (N=42)</th>
<th>mTBI Group (N=22)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Females</strong></td>
<td>13 (31%)</td>
<td>2 (9%)</td>
</tr>
<tr>
<td><strong>Mean Age (yrs)</strong></td>
<td>31.7 (6.5)</td>
<td>32.9 (7.3)</td>
</tr>
<tr>
<td><strong>PTSD</strong></td>
<td>5 (12%)</td>
<td>9 (41%)</td>
</tr>
<tr>
<td><strong>Depression</strong></td>
<td>11 (26%)</td>
<td>7 (32%)</td>
</tr>
<tr>
<td><strong>Anxiety</strong></td>
<td>24 (57%)</td>
<td>16 (73%)</td>
</tr>
</tbody>
</table>
Results

A Mixed-factor Analysis of Covariance (ANCOVA) was conducted on the data.

**Delay** (Immediate vs. Delayed): *Within-subjects variable*

**Group** (mTBI vs. Control): *Between-subjects variable*

**PTS, Depression**: *Covariates*
**Significant Findings**

**Significant main effect of Delay**

\[(F(1,60) = 44.49, p < .001, \eta_p^2 = .43)\]

**Significant Delay X Group interaction**

\[(F(1,60) = 5.8, p = .019, \eta_p^2 = .088)\]

This interaction was significant even when PTS and Depression were included as covariates.

**PTS:** \(F(1,60) = 2.57, p = .114\)

**Depression:** \(F(1,60) = 2.70, p = .106\)
LM 1: Immediate Condition

No group difference (t<1)
LM 2: Delayed Condition

Mean Scores

Control  mTBI

$t (62) = 1.97, p = .043$
Decision Making: The Iowa Gambling Task \cite{Bechara1994}

- Widely used in both clinical and healthy populations \cite{Lezak2012}
- Measure higher-order cognitive skills \cite{Bagneux2013, Cui2015}
- Shown to be sensitive to deficits associated TBI \cite{Bechara2007} including risk-taking

![Diagram of the Iowa Gambling Task]

Computerized using PEBL version 0.14 \cite{Mueller2014}
But you also have lost $150!
Multiple Regression Analysis

**Dependent Variable: Advantageous Deck Score** (Low Risk decks) – (High Risk decks)

**Predictor Variable: mTBI**

The regression model was significant \( F(1,56) = 4.50, \ p = .045 \)

**Significant: mTBI**
\[ \beta = -.264, \ t = -2.05, \ p = .045 \]
Trials were divided into blocks of 20

2 (Group: **Control vs. mTBI**) X 4 (Block Advantageous Deck Selection Score for **Blocks 2, 3, 4, 5**) mixed-factor Analysis of Variance (ANOVA)

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1. Based on conventional scoring methods for the IGT, (Bechara, 2007; Bagneux et al., 2013; Cotrena et al., 2014; Brenner et al., 2015)
There was a significant main effect of Block ($F(3, 165)$=7.34, $p<.001$, partial $\eta^2$=.118)

No significant effect of Group ($F(1,55)$=2.29, $p=.136$, partial $\eta^2$=.04)

Marginally significant Block X Group interaction ($F(3,165)$=3.91, $p=.053$ partial $\eta^2$=.066)

Healthy control group, there was a significant effect of Block ($F(3,105)$=12.33, $p<.001$) mTBI group no effect of Block ($F<1$)
Visual Serial Addition

WRONG!
Requires Updating and Inhibition (Executive Function Skills)

Stress inducing

Time pressure (4 seconds)

Aversive feedback

Longer task
Results

The trials were divided into quartiles (25 trials per quartile).

A Mixed-factor Analysis of Covariance (ANCOVA)

- **Group** (Control vs. mTBI): Between-subjects variable
- **Quartile** (1, 2, 3, 4): Within-subjects variable
- **PTS**: Covariate

**Accuracy**

- Significant effect of Quartile \( (F(3, 150)=4.86, \ p=.003, \ \eta_p^2=.089) \)

- No significant effect of Group \( (F(1,50)=1.68, \ p=.201, \ \eta_p^2=.033) \)

- Significant Quartile X Group interaction \( (F(3,150)=3.08, \ p=.029, \ \eta_p^2=.058) \)
Control: No effect of Quartile (F<1)
mTBI: Significant effect of Quartile (F(3,54)=5.18, p=.003, \( \eta^2_p = .224 \))

* Compared to 2nd quartile, p<.008
Operation Span Task  (Turner & Engle, 1989)

Experimental Measure of Complex Verbal Memory Span

Valid and reliable working memory measures  (Unsworth et al., 2005; Conway et al., 2005)

Measure higher-level skills  (Unsworth & Engle, 2007)
Computerized Operation Span Task

Recall the letters in the order you saw them

Set sizes 4-6
Possible Score range = 0-30
Total Score = Total Correct

Operation Span Task, Turner & Engle, 1989
Computerized using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA)
<table>
<thead>
<tr>
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<th>Control (n=35)</th>
<th>mTBI (n=22)</th>
<th>Group Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Female</td>
<td>6 (17.1%)</td>
<td>3 (13.6%)</td>
<td></td>
</tr>
<tr>
<td>PTSD</td>
<td>3 (8.6%)</td>
<td>12 (54.5%)</td>
<td>$\chi^2 = 15.21^{**}$</td>
</tr>
<tr>
<td>Memory Difficulty</td>
<td>14 (40%)</td>
<td>15 (68.2%)</td>
<td>$\chi^2 = 4.69^*$</td>
</tr>
<tr>
<td>Depression</td>
<td>7 (20%)</td>
<td>6 (27.3%)</td>
<td>$\chi^2 &lt; 1$</td>
</tr>
</tbody>
</table>
Correlational analyses were used to examine the relationship between commonly reported service-related conditions/self-ratings (mTBI, PTS, Memory Rating, BDI) and Operation Span Score

<table>
<thead>
<tr>
<th></th>
<th>mTBI</th>
<th>PTSD</th>
<th>BDI</th>
<th>Memory Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation Span</td>
<td>-.363**</td>
<td>-.185</td>
<td>-.347**</td>
<td>.337*</td>
</tr>
<tr>
<td>(n = 57)</td>
<td>(.005)</td>
<td>(.169)</td>
<td>(.008)</td>
<td>(.010)</td>
</tr>
</tbody>
</table>
mTBI, BDI Score, and Memory Rating were entered as predictor variables in a multiple linear regression

The regression model was significant ($R^2_{adj} = .180$, $F(3,53) = 5.08$, $p = .004$)

Only mTBI significantly predicted lower Operation Span Score ($\beta = -.274$, $t = -2.17$, $p = .035$)
When evaluating cognitive skills in military veterans with mTBI it is important to:

**Consider the unique nature of military culture**
How it impacts report of injury

**Consider the environment**
How it may delay diagnosis
Why the mTBI may be more traumatic

**Consider possible service-related concomitant disorders**
Overlapping symptoms complicate assessment
Referrals may be needed

**Consider the impact of transition**
Which support systems can be activated

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**Overview**
There is emerging research that provides support for the validity of veterans’ self-assessments (Krug & Turkstra, 2015)

We can’t dismiss their symptom reports based on simple memory tests.

Researchers and clinicians are responsible for finding the right tests.

If we fail to document existing memory impairments, veterans don’t get needed services
## Treatment & Treatment Resources

<table>
<thead>
<tr>
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<th>Sleep</th>
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<tbody>
<tr>
<td>mTBI</td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
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Transdisciplinary care is necessary
At ASU:

- Grant-funded Veteran Specialty Clinic in the Speech and Hearing Clinic
- Collaboration with the Pat Tillman Veteran Center
- Specialized training given to the Disability Resource Center
- Collaboration with the Counseling Center
Teammates vs. Expert-Patient Relationship

• Cognitive Coaching
• Motivational Interviewing
• Respects military values
• Considers the transition experience
• Vocationally/Academically relevant

Veteran Specialty Clinic

Veterans self-select for intervention regardless of diagnosis

They complete 7-10 one-hour sessions with a graduate clinician supervised by me
During the initial session Veterans:

- **Identified executive skills** strengths and weaknesses using the adult version of the Executive Skills Checklist¹

- **Provided course information**, work schedules, samples of notes, and descriptions of organization and studying strategies

During weekly sessions Veterans:

- **Identified goals** related to academic success, steps to achieving goals, and barriers to achieving goals

- **Identified memory, attention, and organization strategies** to be used during the week and defined the academic areas where those strategies would be applied

- **Reviewed strategy use and effectiveness** and identified reasons for success or lack of success

- **Revised strategy use**
During weekly sessions, Clinicians:

- Established a teammate rapport (vs. expert – patient)
- Offered evidence-based organization, memory, attention, and active studying strategy options for application on existing courses
- Used motivational interviewing techniques to facilitate participant exploration and self-discovery of barrier behaviors and attitudes
Questions & Discussion
References


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