Assessment and Treatment of Persistent Postconcussive Symptoms in Veterans: Rethinking the Role of Concussion

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INS 2018
• This presentation is based on work supported, in part, by the Department of Veterans Affairs, but does not necessarily represent the views of the Department of Veterans Affairs or the United States Government.
LEARNING OBJECTIVES

• 1. Describe the neuropsychological presentation of treatment-seeking Veterans with history of concussion and persistent cognitive complaints.

• 2. Identify both neurological and non-neurological factors impacting functioning in this population

• 3. Recognize treatment options for individuals with cognitive complaints in the post-acute period following concussion
INTRODUCTION
TRAUMATIC BRAIN INJURY (TBI)

• Insult to the brain caused by an external physical force
• Produces a diminished or altered state of consciousness
• Results in impairments in physical, cognitive, behavioral, and/or emotional functioning
• Presence of a TBI is determined by a thorough history
### CRITERIA FOR SEVERITY OF TBI

(If a patient meets criteria in more than one category of severity, the higher severity level is assigned)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural imaging</td>
<td>Normal</td>
<td>Normal or abnormal</td>
<td>Normal or abnormal</td>
</tr>
<tr>
<td>Loss of Consciousness (LOC)</td>
<td>0-30 min</td>
<td>&gt;30 min and &lt;24 hours</td>
<td>&gt;24 hours</td>
</tr>
<tr>
<td>Alteration of consciousness/ mental state (AOC)*</td>
<td>up to 24 hours</td>
<td>&gt;24 hours; severity based on other criteria</td>
<td></td>
</tr>
<tr>
<td>Posttraumatic amnesia (PTA)</td>
<td>0-1 day</td>
<td>&gt;1 and &lt;7 days</td>
<td>&gt;7 days</td>
</tr>
<tr>
<td>Glasgow Coma Scale (GCS) (best available score in first 24 hours)**</td>
<td>13-15</td>
<td>9-12</td>
<td>&lt;9</td>
</tr>
</tbody>
</table>

*Alteration of mental status must be immediately related to the trauma to the head. Typical symptoms would be looking and feeling dazed and uncertain of what is happening, confusion, and difficulty thinking clearly or responding appropriately to mental status questions, and being unable to describe events immediately before or after the trauma event.

**In April 2015, the DoD released a memorandum recommending against the use of GCS scores to diagnose TBI. See the memorandum for additional information. [3]

About 42 million people sustain concussions annually
Common symptoms include headache, dizziness, problems with attention and concentration, fatigue, sleep difficulties, and irritability (Broshek, De Marco, & Freeman, 2015; Carroll et al., 2004; Lovell et al., 2006).

<table>
<thead>
<tr>
<th>Physical Symptoms:</th>
<th>Cognitive Symptoms:</th>
<th>Behavior/Emotional Symptoms:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache, dizziness,</td>
<td>Problems with attention,</td>
<td>Depression, anxiety, agitation, irritability, impulsivity, aggression</td>
</tr>
<tr>
<td>balance disorders,</td>
<td>concentration, memory, speed of processing, judgment, executive control</td>
<td></td>
</tr>
<tr>
<td>nausea, fatigue,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sleep disturbance,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>blurred vision,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>sensitivity to light,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hearing difficulties/loss,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tinnitus, sensitivity to</td>
<td></td>
<td></td>
</tr>
<tr>
<td>noise, seizure,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>transient neurological</td>
<td></td>
<td></td>
</tr>
<tr>
<td>abnormalities, numbness,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tingling</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TBI COURSE

• Barring any intervening causes, the trajectory of recovery of cognitive symptoms is improvement or plateau

• In the vast majority of cases, cognitive symptoms of mild TBI resolve within 1 week

• World Health Organization - except in rare cases, objective cognitive deficits attributable to the concussive event do not persist beyond three-months post-injury (Carroll et al., 2004).

• Despite this, for a sizable minority of cases [15-30%;] symptoms do not resolve as expected (Belanger et al., 2009)
VETERANS
DoD Numbers for Traumatic Brain Injury Worldwide – Totals

2000 - 2017 (Q1-Q3)

- **Penetrating**: 5,157
- **Severe**: 3,942
- **Moderate**: 35,674
- **Mild**: 308,853
- **Not Classifiable**: 21,604

**Total - All Severities**: 375,230

Source: Defense Medical Surveillance System (DMSS), Theater Medical Data Store (TMDS) provided by the Armed Forces Health Surveillance Center (AFHSC)

Prepared by the Defense and Veterans Brain Injury Center (DVBIC)

*Percentages may not add up to 100% due to rounding*
~20% of OEF/OIF Veterans have sustained a concussion
• 56,695 Iraq/Afghanistan Veterans enrolled in VA healthcare have been evaluated or treated for conditions possibly related to TBI (Bagalman, 2013; Sayer et al., 2009).

• 40% of patients with a history of mTBI reported at least one post-concussive symptom one year post-injury

• Veterans with persistent postconcussive symptoms use 2-3 times more medical visits than peers, with treatment averaging two years (King, Wade, & Beehler, 2014).

• High rates of comorbidity between TBI and mental health conditions, particularly PTSD
  • In Veterans with a history of mild TBI, rate of PTSD is 43.9% compared to 16.2% in those with other types of injuries and only 9.1% in those without physical injuries
Examination of over 13000 records of veterans screened for TBI found that over 80% of those with positive screens had psychiatric diagnoses:

- 3 times greater likelihood of PTSD
- 2 times greater likelihood of depression
- 2 times greater likelihood of substance use disorder (Carlson et al., 2010)
411 Veterans with history of concussion presented with cognitive complaints.

- Impaired: 28%
- PVT below cutoff: 30%
- WNL: 42%

(Jak et al., 2015)
TREATMENT

• Cognitive-related difficulties can be treated symptomatically, regardless of the etiology of the symptom.

• stress management

• cognitive behavioral interventions

• In concert with optimizing overall health (e.g., sleep hygiene, pain management, dizziness management) and comorbid conditions (e.g., PTSD, MDD, anxiety disorder, SUD).
TREATMENT

• Psychoeducation and expectation management are key to improvement in cases of protracted recovery following mTBI
  • What is a TBI or concussion
  • Expected symptoms
  • Expected recovery
  • Discussion of comorbid conditions and contributions to cognitive functioning

• Use principles of risk communication
  • provide reassurance,
  • promote normalization
  • minimize perception of disability
  • reduce perception of neurologically-based deficits
  • guide treatment based on symptoms and functional needs
TREATMENT OF MILD COGNITIVE DEFICITS

- Gold standard treatment for mTBI related cognitive deficits
  - Psychoeducation about TBI (Mittenberg, Canyock, Condit, & Patton, 2001)
  - Expectation management regarding recovery from symptoms (Mittenberg et al., 2001)
  - Compensatory cognitive rehabilitation (Cicerone et al., 2000)
    - Effective in improving cognitive/daily functioning and mood in OEF/OIF veterans with a history of TBI (Twamley et al., 2014; Huckans et al., 2010)

- Cognitive Symptom Management and Rehabilitation Therapy (CogSMART):
  - 10-weeks, Manualized
  - Compensatory strategies: prospective memory/life organization, attention and concentration, learning and memory, and executive functioning
  - Focus on internal (e.g., mnemonics) and external (e.g., effective use of calendars or smartphones) strategies
  - Psychoeducation about TBI, postconcussive symptoms, and mood symptoms
<table>
<thead>
<tr>
<th>Module</th>
<th>Compensatory strategies and habits taught in CogSMART</th>
</tr>
</thead>
</table>
| Postconcussive Symptoms      | 1. Psychoeducation regarding the natural course of postconcussive symptoms  
2. Appropriate pacing, use of routines, lifestyle strategies  
3. Stress reduction (eg, progressive muscle relaxation, abdominal breathing, mindfulness, visualization, grounding)  
4. Sleep hygiene education, headache management, and education regarding depression, anxiety, and PTSD |
| Prospective Memory           | 1. Daily calendar use  
2. To-do lists and prioritizing tasks  
3. Linking tasks; using “can’t miss reminders” to cue tasks |
| Attention and Vigilance      | 1. Conversational vigilance skills (reduce distractions, eye contact, paraphrasing, and asking questions)  
2. Task vigilance skills (paraphrase instructions, use self-talk during tasks to maintain focus) |
| Learning and Memory          | 1. Encoding strategies (write things down, paraphrasing/repetition, association, chunking, categorizing, acronyms, rhymes, visual imagery, name-learning strategies)  
2. Retrieval strategies (systematic searching) and organizational strategies for general learning and memory |
| Executive Functioning        | 1. Six-step problem-solving method (define problem, brainstorm solutions, evaluate solutions, select a solution, try it, evaluate how it worked)  
2. Self-talk while solving problems  
3. Hypothesis testing and self-monitoring |

Abbreviations: CogSMART, Cognitive Symptom Management and Rehabilitation Therapy; PTSD, posttraumatic stress disorder.
Pilot work & clinical trial data have shown CogSMART is associated with:

- Decreases in mood symptoms
- Decreases in post-concussive symptoms
- Objective improvements in attention, memory, & executive functioning
- Increases in life satisfaction
- Improvements persist for at least 6 months post treatment

Huckans et al., 2010; Twamley, Jak, et al., 2014; Twamley et al., 2014
CogSMART Compensatory Cognitive Training for Traumatic Brain Injury: Effects Over 1 Year

Elizabeth W. Twamley, PhD; Kelsey R. Thomas, MS; Amber M. Gregory, BA; Amy J. Jak, PhD; Mark W. Bondi, PhD; Dean C. Delis, PhD; James B. Lohr, MD

Daniel Storzbach, PhD; Elizabeth W. Twamley, PhD; Mai S. Roost, PhD; Shahrokh Golshan, PhD; Rhonda M. Williams, PhD; Maya O’Neil, PhD; Amy J. Jak, PhD; Aaron P. Turner, PhD; Halina M. Kowalski, MA; Kathleen F. Pagulayan, PhD; Marilyn Huckans, PhD

**Objective:** The purpose of the study was to evaluate the efficacy of group-based compensatory cognitive training (CCT) for Operation Enduring Freedom (OEF)/Operation Iraqi Freedom (OIF)/Operation New Dawn (OND) Veterans with a history of mild traumatic brain injury. **Method:** One hundred nineteen OEF/OIF/OND Veterans with history of mild traumatic brain injury participated at 3 sites, and 50 of the Veterans were randomized to CCT group, while 69 Veterans were randomized to the usual care control group. The CCT group participated in 10 weeks of CCT. Both CCT and usual care groups were assessed at baseline, 5 weeks (midway through CCT), 10 weeks (immediately following CCT), and 15 weeks (6 month follow-up) on measures of subjective cognitive complaining, use of cognitive strategies, psychological functioning, and objective cognitive performance. **Results:** Veterans who participated in CCT reported significantly fewer cognitive and memory difficulties and greater use of cognitive strategies. They also demonstrated significant improvements on neurocognitive tests of attention, learning, and executive functioning, which were 3 of the cognitive domains targeted in CCT. **Conclusions:** Findings indicate that training in compensatory cognitive strategies facilitates behavioral change (use of cognitive strategies) as well as both subjective and objective improvements in targeted cognitive domains. **Keywords:** cognitive training, mild traumatic brain injury, OEF/OIF/OND Veterans
PERSISTENT POSTCONCUSSIVE SYMPTOMS

- Occur readily in healthy individuals with no history of concussion
- *No symptom unique* to only mild TBI
- Symptoms overlap with one or more other conditions

70-80% of healthy participants met DSM-IV (79.6%) or ICD-10 (72.1%) self-report criteria for Postconcussive Syndrome

(Iverson & Lange, 2003)
PERSISTENT POSTCONCUSSIVE SYMPTOMS

• Initial concussive event may have resulted in expected post-concussive symptoms

• Persistence of these symptoms beyond the expected recovery period is likely independent of, or at best only indirectly related to the concussion.

• Poor pre-injury coping increases likelihood of adopting maladaptive coping strategies following concussion

• Psychological factors likely play a large role in symptom persistence in persistent symptoms following concussion

• “good old days” bias

• Iatrogenic effects

• Non-specificity of symptoms contributes to the challenge in treating them

• Symptoms that persist beyond the expected period of recovery also become more intractable and difficult to treat (Mittenberg, Tremont, Zielinski, Fichera, & Rayls, 1996).
NEUROPSYCHOLOGY OF PTSD

• Cognitive deficits associated with PTSD (Vasterling et al. 2002)
  • Attention
  • Learning and verbal memory
  • Working memory
  • Executive functions – inhibition, interference

  ▪ Deficits align with limbic and paralimbic regions – prefrontal regions subserving arousal regulation and inhibition

• PTSD is associated with longer lasting cognitive difficulties than mTBI (Vasterling et al., 2012).

• May also be associated with worsening cognition over time

• Those with PTSD are twice as likely to develop dementia than those without (Yaffe et al., 2010).

• With time and ongoing symptoms, neuronal systems in those with PTSD may become overresponsive, leading to worsening cognition over time.
  • Stress sensitization - stress leads to changes in neurotransmitter/neurohormonal responses, that can create or exacerbate PTSD symptoms
Fig. 1 Potential role of executive dysfunction in the development of PTSD.
OVERLAPPING SYMPTOMS

• Postconcussion Syndrome (PCS)
  • Insomnia
  • Impaired memory
  • Poor concentration
  • Depression
  • Anxiety
  • Irritability

• Headache
• Dizziness
• Fatigue
• Noise/light intolerance

• PTSD
  • Insomnia
  • Memory problems
  • Poor concentration
  • Depression
  • Anxiety
  • Irritability

• Stress symptoms
• Emotional numbing
• Avoidance
VETERANS PRESENTING FOR TREATMENT OF COGNITIVE COMPLAINTS

- 411 Veterans with history of concussion presented with cognitive complaints
- Less than 30% of Veterans with a history of concussion had objective deficits upon formal testing
- ~85% had PTSD or other comorbid mental health concerns

Jak et al., 2015
Veterans Presenting for Treatment of Cognitive Complaints

Table 2: Neuropsychological Comparisons by Group

<table>
<thead>
<tr>
<th>Neuropsychological Test</th>
<th>Pass PVT</th>
<th>Fail PVT</th>
<th>Test Statistic</th>
<th>WNL</th>
<th>Impaired</th>
<th>Test Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>WCST Perseverative Responses T-score</td>
<td>47.1 (9.8)</td>
<td>46.6 (8.8)</td>
<td>$F_{(1,368)}=1.3$</td>
<td>49.2 (9.0)</td>
<td>43.8 (10.1)</td>
<td>$F_{(1,279)}=21.8^*$</td>
</tr>
<tr>
<td></td>
<td>79% WNL</td>
<td>79% WNL</td>
<td>$d_{=.05}$</td>
<td>80% WNL</td>
<td>80% WNL</td>
<td>$d_{=.56}$</td>
</tr>
<tr>
<td>WAIS Digit Span Age SS</td>
<td>9.0 (2.7)</td>
<td>7.1 (2.9)</td>
<td>$F_{(1,397)}=31.1^*$</td>
<td>9.8 (2.5)</td>
<td>7.7 (2.4)</td>
<td>$F_{(1,276)}=50.7^*$</td>
</tr>
<tr>
<td></td>
<td>83% WNL</td>
<td>50% WNL</td>
<td>$d_{=.68}$</td>
<td>84% WNL</td>
<td>84% WNL</td>
<td>$d_{=.86}$</td>
</tr>
<tr>
<td>DKEFS Trails Visual Scanning SS</td>
<td>10.3 (2.9)</td>
<td>7.1 (4.5)</td>
<td>$F_{(1,390)}=60.5^*$</td>
<td>11.11 (2.2)</td>
<td>8.96 (3.5)</td>
<td>$F_{(1,274)}=40.5^*$</td>
</tr>
<tr>
<td></td>
<td>89% WNL</td>
<td>59% WNL</td>
<td>$d_{=.85}$</td>
<td>90% WNL</td>
<td>90% WNL</td>
<td>$d_{=.74}$</td>
</tr>
<tr>
<td>DKEFS Trails Switching SS</td>
<td>9.2 (3.2)</td>
<td>6.8 (3.7)</td>
<td>$F_{(1,389)}=38.5^*$</td>
<td>10.3 (2.6)</td>
<td>7.6 (3.3)</td>
<td>$F_{(1,275)}=59.7^*$</td>
</tr>
<tr>
<td></td>
<td>67% WNL</td>
<td>65% WNL</td>
<td>$d_{=.69}$</td>
<td>82% WNL</td>
<td>82% WNL</td>
<td>$d_{=.74}$</td>
</tr>
<tr>
<td>WAIS Symbol Search Age SS</td>
<td>10.5 (2.8)</td>
<td>7.9 (3.5)</td>
<td>$F_{(1,254)}=37.4^*$</td>
<td>11.1 (2.7)</td>
<td>10.5 (2.8)</td>
<td>$F_{(1,174)}=13.0^*$</td>
</tr>
<tr>
<td></td>
<td>91% WNL</td>
<td>61% WNL</td>
<td>$d_{=.82}$</td>
<td>94% WNL</td>
<td>94% WNL</td>
<td>$d_{=.91}$</td>
</tr>
<tr>
<td>DKEFS Letter Fluency SS</td>
<td>9.5 (3.2)</td>
<td>8.7 (3.3)</td>
<td>$F_{(1,387)}=4.9$</td>
<td>10.1 (3.1)</td>
<td>8.5 (2.9)</td>
<td>$F_{(1,276)}=18.7^*$</td>
</tr>
<tr>
<td></td>
<td>81% WNL</td>
<td>69% WNL</td>
<td>$d_{=.25}$</td>
<td>82% WNL</td>
<td>82% WNL</td>
<td>$d_{=.22}$</td>
</tr>
<tr>
<td>DKEFS Cat. Fluency SS</td>
<td>10.3 (3.6)</td>
<td>8.5 (3.2)</td>
<td>$F_{(1,385)}=25.2^*$</td>
<td>11.6 (3.1)</td>
<td>8.5 (3.4)</td>
<td>$F_{(1,275)}=63.1^*$</td>
</tr>
<tr>
<td></td>
<td>85% WNL</td>
<td>73% WNL</td>
<td>$d_{=.53}$</td>
<td>85% WNL</td>
<td>85% WNL</td>
<td>$d_{=.49}$</td>
</tr>
<tr>
<td>CVLT-II Trials 1-5 T-score</td>
<td>47.2 (10.3)</td>
<td>35.6 (11.3)</td>
<td>$F_{(1,400)}=91.4^*$</td>
<td>51.5 (8.0)</td>
<td>40.8 (10.0)</td>
<td>$F_{(1,278)}=101.2^*$</td>
</tr>
<tr>
<td></td>
<td>78% WNL</td>
<td>41% WNL</td>
<td>$d_{=.53}$</td>
<td>80% WNL</td>
<td>80% WNL</td>
<td>$d_{=.95}$</td>
</tr>
<tr>
<td>CVLT-II SDFR z-score</td>
<td>-.33 (1.1)</td>
<td>-1.6 (1.0)</td>
<td>$F_{(1,400)}=106.4^*$</td>
<td>.18 (0.8)</td>
<td>-1.1 (0.95)</td>
<td>$F_{(1,278)}=141.5^*$</td>
</tr>
<tr>
<td></td>
<td>80% WNL</td>
<td>41% WNL</td>
<td>$d_{=.12}$</td>
<td>80% WNL</td>
<td>80% WNL</td>
<td>$d_{=.46}$</td>
</tr>
<tr>
<td>CVLT-II LDFR z-score</td>
<td>-.49 (1.1)</td>
<td>-1.8 (1.3)</td>
<td>$F_{(1,399)}=96.4^*$</td>
<td>.04 (0.81)</td>
<td>-1.3 (1.0)</td>
<td>$F_{(1,277)}=143.3^*$</td>
</tr>
<tr>
<td></td>
<td>75% WNL</td>
<td>28% WNL</td>
<td>$d_{=.10}$</td>
<td>73% WNL</td>
<td>73% WNL</td>
<td>$d_{=.29}$</td>
</tr>
<tr>
<td>TOMM Trial 2 raw</td>
<td>49.6 (2.6)</td>
<td>41.2 (9.0)</td>
<td>$F_{(1,289)}=123.7^*$</td>
<td>49.9 (0.5)</td>
<td>49.10 (4.0)</td>
<td>$F_{(1,178)}=3.9$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$d_{=.27}$</td>
<td></td>
<td></td>
<td>$d_{=.28}$</td>
</tr>
<tr>
<td>TOMM Delay raw</td>
<td>49.6 (1.4)</td>
<td>39.7 (9.6)</td>
<td>$F_{(1,192)}=128.3^*$</td>
<td>49.9 (0.3)</td>
<td>49.1 (2.1)</td>
<td>$F_{(1,131)}=11.1^*$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$d_{=1.44}$</td>
<td></td>
<td></td>
<td>$d_{=.53}$</td>
</tr>
<tr>
<td>CVLT Forced Choice raw</td>
<td>15.9 (.3)</td>
<td>13.7 (2.6)</td>
<td>$F_{(1,396)}=190.2^*$</td>
<td>15.9 (0.25)</td>
<td>15.8 (0.4)</td>
<td>$F_{(1,276)}=7.8$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$d_{=1.19}$</td>
<td></td>
<td></td>
<td>$d_{=0.30}$</td>
</tr>
</tbody>
</table>

Note. * $\leq .003$

PVT = Performance Validity Test; WNL = within normal limits; WCST = Wisconsin Card Sorting Test; WAIS = Wechsler Adult Intelligence Scale; SS = Scaled Score; DKEFS = Delis-Kaplan Executive Function System; CVLT-II = California Verbal Learning Test-II; TOMM = Test of Memory Malingering
Veterans Presenting for Treatment of Cognitive Complaints

### Mood and symptom ratings by clinical diagnostic group

<table>
<thead>
<tr>
<th>Symptom inventory</th>
<th>Pass PVT</th>
<th>Fail PVT</th>
<th>Test statistic</th>
<th>WNL</th>
<th>Impaired</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BDI</strong></td>
<td>21.4 (11.2)</td>
<td>28.7 (12.8)</td>
<td>$F(1, 368) = 25.6^*$</td>
<td>20.5 (11.2)</td>
<td>22.7 (10.9)</td>
<td>$F(1, 281) = 2.5$</td>
</tr>
<tr>
<td><strong>BAI</strong></td>
<td>16.4 (11.6)</td>
<td>24.3 (12.1)</td>
<td>$F(1, 319) = 20.1^*$</td>
<td>16.3 (12.0)</td>
<td>16.5 (11.1)</td>
<td>$F(1, 230) = .01$</td>
</tr>
<tr>
<td><strong>NSI</strong></td>
<td>35.1 (13.9)</td>
<td>46.9 (15.5)</td>
<td>$F(1, 403) = 30.9^*$</td>
<td>35.5 (13.8)</td>
<td>34.5 (14.2)</td>
<td>$F(1, 216) = .25$</td>
</tr>
<tr>
<td><strong>PCL</strong></td>
<td>52.6 (16.1)</td>
<td>61.5 (14.8)</td>
<td>$F(1, 317) = 15.3^*$</td>
<td>52.0 (16.6)</td>
<td>53.6 (15.6)</td>
<td>$F(1, 256) = .61$</td>
</tr>
</tbody>
</table>

### Correlations between neurobehavioral symptoms, mental health symptoms, overall cognitive performance, and injury variables in the pass PVT group

<table>
<thead>
<tr>
<th>Variable</th>
<th>BAI</th>
<th>NSI</th>
<th>PCL</th>
<th>Impaired tests</th>
<th>TBIs</th>
<th>LOC</th>
<th>PTA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BDI</strong></td>
<td>.65*</td>
<td>.57*</td>
<td>.51*</td>
<td>.11</td>
<td>-.02</td>
<td>-.06</td>
<td>.02</td>
</tr>
<tr>
<td><strong>BAI</strong></td>
<td>.70*</td>
<td>.52*</td>
<td>.54*</td>
<td>.04</td>
<td>.06</td>
<td>-.01</td>
<td>.10</td>
</tr>
<tr>
<td><strong>NSI</strong></td>
<td>.54*</td>
<td>.54*</td>
<td>.54*</td>
<td>.04</td>
<td>.09</td>
<td>.06</td>
<td>-.09</td>
</tr>
</tbody>
</table>

Jak et al., 2015
**VETERANS PRESENTING FOR TREATMENT OF COGNITIVE COMPLAINTS**

- Often, have subjective complaints that are not supported by objective testing.
- 30% of this *clinical* sample have poor performance on effort measures when there is no other obvious secondary gain – comparable to forensic rates.
- Despite generally high levels of depression and PTSD among OEF/OIF Veterans with a history of mild TBI, these symptoms/diagnoses were significantly more prominent among those who performed poorly on PVT’s.
- In the context of a failure to find differences in injury variables between PVT groups.
- Not surprisingly, Veterans who failed PVTs performed significantly worse on almost all neuropsychological measures administered.
- However, mean scores in both groups generally were within the normal range.
TREATMENT

Model of dynamic relationship between etiology, symptom development and persistence, and treatment in comorbid PTSD and TBI. Adapted from Vasterling, Bryant, and Keane (2012).
PTSD TREATMENT

- Cognitive Processing Therapy (CPT), a cognitive behavioral treatment (CBT) for PTSD
- Manualized 12-week treatment, 50 min sessions
- Focuses on identifying the content of trauma-related thoughts & beliefs and addressing their impact on emotions and behaviors
- Patients are taught to recognize and challenge thought patterns
- Themes: trust, safety, power/control, self-esteem, intimacy
- Lots of empirical support for its efficacy and effectiveness
CASE STUDY - CPT ONLY

- Improvements in Visual Attention and Processing Speed
- Resolution of stuttering

Boyd et al., 2015
Fig. 1. Model of dynamic relationship between etiology, symptom development and persistence, and treatment in comorbid PTSD and TBI. Adapted from Vasterling, Bryant, and Keane (2012).
Hybrid Treatment: SMART-CPT

- Enhanced Cognitive Rehabilitation to Treat Veterans with Comorbid TBI and PTSD; aka – SMART-CPT
- Integrates compensatory cog rehab principles into Cognitive Processing Therapy (CPT) to target comorbid PTSD/TBI
- Hybrid treatment is 12 weekly sessions, 75 min/session
- SMART-CPT keeps all aspects of CPT and adds:
  » Psychoeducation regarding TBI and comorbidities
  » Select compensatory cog rehab principles
  » More concrete language
  » Repetition of key points, written summaries
  » Built in breaks
  » Simplified/restructured homework pages

DoD Award W81XWH-11-1-0641
Jak et al., 2015
# Challenging Beliefs Worksheet

<table>
<thead>
<tr>
<th>A. Situation</th>
<th>B. Thought(s)</th>
<th>D. Challenging Thoughts</th>
<th>E. Problematic Patterns</th>
<th>F. Alternative Thought(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe the event, thought or belief leading to the unpleasant emotion(s).</td>
<td>Write thought(s) related to Column A. Rate belief in each thought below from 0-100% (How much do you believe this thought?)</td>
<td>Use Challenging Questions to examine your automatic thoughts from Column B. Is the thought balanced and factual or extreme?</td>
<td>Use the Patterns of Problematic Thinking Worksheet to decide if this is one of your problematic patterns of thinking.</td>
<td>What else can I say instead of Column B? How else can I interpret the event instead of Column B? Rate belief in alternative thought(s) from 0-100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Emotion(s)</td>
<td><strong>Evidence For?</strong></td>
<td><strong>Jumping to conclusions:</strong></td>
<td><strong>Exaggerating or minimizing:</strong></td>
<td><strong>Disregarding important aspects:</strong></td>
</tr>
<tr>
<td>Specify sad, angry, etc., and rate how strongly you feel each emotion from 0-100%</td>
<td><strong>Evidence Against?</strong></td>
<td><strong>Oversimplifying:</strong></td>
<td><strong>Over-generalizing:</strong></td>
<td><strong>Mind reading:</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Habit or fact?</strong></td>
<td><strong>Over-rate Old Thought(s)</strong></td>
<td><strong>Low versus high probability?</strong></td>
<td><strong>Emotional reasoning:</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Interpretations not accurate?</strong></td>
<td>Re-rate how much you now believe the thought(s) in Column B from 0-100%</td>
<td><strong>All or none?</strong></td>
<td>Now what do you feel? 0-100%</td>
</tr>
<tr>
<td></td>
<td><strong>Extreme or exaggerated?</strong></td>
<td></td>
<td><strong>Out of context?</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Out of context?</strong></td>
<td></td>
<td><strong>Source unreliable?</strong></td>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Challenging Beliefs Worksheet

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activating Event</td>
<td>Belief/Stuck point</td>
<td>Consequence</td>
</tr>
<tr>
<td>&quot;Something happens&quot;</td>
<td>&quot;I tell myself something&quot;</td>
<td>How does the stuck point make me feel?</td>
</tr>
<tr>
<td>Rate strength of belief from 0-100% ___ %</td>
<td>Rate strength of emotion ___ %</td>
<td></td>
</tr>
</tbody>
</table>

## D Challenging Questions
- Evidence for the stuck point?
- Evidence against the stuck point?
- Are you taking the situation out of context and only focusing on one aspect of the event? (Yes / No)
- Are you thinking in all-or-none terms? (e.g., either-or, black-white, right-wrong, good-bad) (Yes / No)
- What is the probability (low to high) this stuck point is true? (Low 1 2 3 4 5 6 7 High)

## E Thought Distorting
- Jumping to conclusions
- Exaggerating or minimizing
- Disregarding important aspects
- Oversimplifying
- Over-generalizing
- Mind reading
- Emotional reasoning

## F New Belief
What can I tell myself in the future?

## G New Consequence
How does the new belief make me feel?

Rate strength of new belief from 0-100 % _______ %
Rate strength of new emotion from 0-100% _______ %
Evaluation of a hybrid treatment for Veterans with comorbid traumatic brain injury and posttraumatic stress disorder: Study protocol for a randomized controlled trial

Amy J. Jak, Robin Aupperle, Carie S. Rodgers, Ariel J. Lang, Dawn M. Schiefer, Sonya B. Norman, Elizabeth W. Twamley...

72 veterans with mTBI and PTSD (see Inclusion/Exclusion Criteria)

Random Assignment

36 CPT

36 SMART-CPT

Fidelity measures:
Random 10% of CPT and SMART-CPT sessions coded for fidelity; 20% of other assessments double-scored/entered

Baseline Assessment:
PCL, WARCAT, NSI, BDI
Neuropsychological functioning
QOLI

3-month Assessment:
PCL, NSI, BDI
Neuropsychological Functioning
CSQ
QOLI

6-month Assessment:
PCL, NSI, BDI
Neuropsychological Functioning
QOLI

Weekly assessment of PTSD symptoms and treatment compliance. NSI at 6 weeks.
## Participants

<table>
<thead>
<tr>
<th></th>
<th>Total Sample (N=100)</th>
<th>CPT-C (N=49)</th>
<th>SMART-CPT (N=51)</th>
<th>t, χ², or F (df)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>34.39 (7.89)</td>
<td>33.94 (7.27)</td>
<td>34.82 (8.50)</td>
<td>-0.56 (98)</td>
<td>0.578</td>
</tr>
<tr>
<td>Education, years</td>
<td>13.69 (1.83)</td>
<td>13.88 (1.65)</td>
<td>13.51 (1.98)</td>
<td>1.00 (98)</td>
<td>0.317</td>
</tr>
<tr>
<td>Male, %</td>
<td>89.0%</td>
<td>87.8%</td>
<td>90.2%</td>
<td>χ²=1.15 (1)</td>
<td>0.758</td>
</tr>
<tr>
<td>Non-Caucasian, %</td>
<td>53%</td>
<td>59.2%</td>
<td>47.1%</td>
<td>χ²=1.48 (1)</td>
<td>0.155</td>
</tr>
<tr>
<td>Loss of Consciousness, minutes *</td>
<td>4.50 (8.84)</td>
<td>5.49 (8.90)</td>
<td>3.61 (8.78)</td>
<td>1.05 (95)</td>
<td>0.297</td>
</tr>
<tr>
<td>Number of TBIs</td>
<td>2.81 (1.92)</td>
<td>2.90 (1.99)</td>
<td>2.73 (1.87)</td>
<td>.44 (97)</td>
<td>0.661</td>
</tr>
<tr>
<td>Percentage Service Connection</td>
<td>57.10 (38.70)</td>
<td>56.73 (37.88)</td>
<td>57.45 (39.84)</td>
<td>-0.09 (98)</td>
<td>0.927</td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Completion, %</td>
<td>53.0%</td>
<td>49.0%</td>
<td>56.9%</td>
<td>χ²=6.2 (1)</td>
<td>0.548</td>
</tr>
<tr>
<td>Prior PTSD Treatment, %</td>
<td>57.0%</td>
<td>55.1%</td>
<td>58.8%</td>
<td>χ²=1.14 (1)</td>
<td>0.840</td>
</tr>
<tr>
<td>Prior Cognitive Rehabilitation, %</td>
<td>1.0%</td>
<td>2.1%</td>
<td>0%</td>
<td>χ²=1.03 (1)</td>
<td>0.495</td>
</tr>
<tr>
<td>Total sessions completed</td>
<td>7.96 (4.74)</td>
<td>7.37 (4.95)</td>
<td>8.53 (4.51)</td>
<td>-1.23 (98)</td>
<td>0.222</td>
</tr>
<tr>
<td>Average time per session, minutes</td>
<td>79.77 (19.24)</td>
<td>72.65 (16.06)</td>
<td>86.03 (19.77)</td>
<td>-3.53 (90)</td>
<td>0.001</td>
</tr>
<tr>
<td>Symptom Severity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCL-S</td>
<td>59.35 (10.65)</td>
<td>61.06 (9.92)</td>
<td>57.63 (11.17)</td>
<td>1.61 (96)</td>
<td>0.111</td>
</tr>
<tr>
<td>NSI</td>
<td>46.56 (14.12)</td>
<td>48.61 (14.92)</td>
<td>44.51 (13.10)</td>
<td>1.45 (96)</td>
<td>0.151</td>
</tr>
<tr>
<td>BDI-II</td>
<td>27.68 (10.27)</td>
<td>27.29 (9.62)</td>
<td>28.06 (10.96)</td>
<td>-0.37 (95)</td>
<td>0.714</td>
</tr>
<tr>
<td>Cognitive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WRAT Reading</td>
<td>97.02 (10.00)</td>
<td>97.08 (10.63)</td>
<td>96.96 (9.44)</td>
<td>0.27 (1.95)</td>
<td>0.603</td>
</tr>
<tr>
<td>WAIS-IV Processing Speed Index</td>
<td>91.51 (13.21)</td>
<td>90.10 (15.18)</td>
<td>92.88 (10.93)</td>
<td>0.22 (1.94)</td>
<td>0.639</td>
</tr>
<tr>
<td>CVLT-II 1-5 Learning Total</td>
<td>45.39 (9.93)</td>
<td>43.35 (9.72)</td>
<td>47.39 (9.83)</td>
<td>3.25 (1.95)</td>
<td>0.075</td>
</tr>
<tr>
<td>CVLT-II SDFR</td>
<td>-5.4 (1.96)</td>
<td>-6.7 (2.93)</td>
<td>-4.0 (0.98)</td>
<td>0.85 (1.95)</td>
<td>0.358</td>
</tr>
<tr>
<td>CVLT-II LDFR</td>
<td>-6.9 (1.13)</td>
<td>-8.6 (1.07)</td>
<td>-5.2 (1.19)</td>
<td>0.79 (1.95)</td>
<td>0.376</td>
</tr>
<tr>
<td>WAIS-IV Digit Span</td>
<td>8.36 (2.59)</td>
<td>8.35 (2.53)</td>
<td>8.38 (2.67)</td>
<td>0.64 (1.96)</td>
<td>0.426</td>
</tr>
<tr>
<td>D-KEFS Trail-Making</td>
<td>8.85 (2.78)</td>
<td>8.73 (2.77)</td>
<td>8.96 (2.81)</td>
<td>0.02 (1.94)</td>
<td>0.879</td>
</tr>
<tr>
<td>Number-Letter Switching</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-KEFS Color Word Inhibition</td>
<td>7.80 (4.04)</td>
<td>7.66 (4.45)</td>
<td>7.94 (3.65)</td>
<td>.05 (1.93)</td>
<td>0.829</td>
</tr>
<tr>
<td>WCST-64 Total Errors</td>
<td>48.08 (8.90)</td>
<td>48.06 (8.93)</td>
<td>48.10 (8.97)</td>
<td>0.04 (1.94)</td>
<td>0.835</td>
</tr>
<tr>
<td>TOMM Trial 2</td>
<td>47.45 (4.54)</td>
<td>46.69 (5.29)</td>
<td>48.18 (3.58)</td>
<td>-1.65 (98)</td>
<td>0.103</td>
</tr>
<tr>
<td>TOMM Retention Trial</td>
<td>46.80 (5.54)</td>
<td>45.94 (6.59)</td>
<td>47.63 (4.20)</td>
<td>-1.53 (98)</td>
<td>0.128</td>
</tr>
<tr>
<td>QOLI-B General Life Satisfaction</td>
<td>4.07 (1.30)</td>
<td>4.19 (1.21)</td>
<td>3.96 (1.38)</td>
<td>.86 (95)</td>
<td>0.390</td>
</tr>
</tbody>
</table>
CHANGE IN MENTAL HEALTH AND NEUROBEHAVIORAL SYMPTOMS

**Change in BDI Scores**

**Change in PCL Scores**

**Change in NSI scores**
CHANGE IN COGNITIVE FUNCTIONING

- **Attention**: 
  - SMART-CPT: *P = .01*
  - CPT-C: 

- **Verbal Learning**: 
  - SMART-CPT: *P < .01*
  - CPT-C: 

- **Verbal Memory**: 
  - SMART-CPT: *P < .05*
  - CPT-C: 

- **Novel Problem Solving**: 
  - SMART-CPT: *P < .05*
SUMMARY

- Individuals with a history of concussion and persistent post-concussive symptoms can successfully complete structured and empirically supported mental health therapies with or without modifications.
- Both CPT-C and SMART-CPT resulted in clinically significant reductions in PTSD and post-concussive symptomatology as well as improvements in quality of life and objective cognitive functioning.
- Adding cognitive rehabilitation to mental health treatment does provide differential benefit in the cognitive domains of attention, learning/memory, and novel problem solving.
VETERANS PRESENTING FOR TREATMENT OF COGNITIVE COMPLAINTS

• 411 Veterans with history of concussion presented with cognitive complaints

• Less than 30% of Veterans with a history of concussion had objective deficits upon formal testing

• ~85% had PTSD or other comorbid mental health concerns

Jak et al., 2015
POLYTRAUMA CLINICAL TRIAD

Lew et al., 2009
POLYTRAUMA CLINICAL TRIAD

- 42-64% of Veterans with history of TBI experience this triad (Taylor et al., 2012).

- Local data - 81% of OEF/OIF/OND Veterans with a history of mTBI with persistent cognitive complaints are also diagnosed with PTSD and endorse moderate (or higher) pain.

- High level of comorbidity complicates recovery from any of the components of the triad and magnifies difficulties with cognitive functioning.
POLYTRAUMA CLINICAL TRIAD

Pain Severity

- Low Pain
- High Pain

PTSD Symptoms

Visit

Pretreatment Posttreatment 3 Month Follow-up

Pain Interference

- Low Pain
- High Pain

PTSD Symptoms

Visit

Pretreatment Posttreatment 3 Month Follow-up
POLYTRAUMA CLINICAL TRIAD

• Pain severity and interference were positively correlated with PTSD symptoms ($r’s > .27$, $p’s < .007$) and postconcussive symptoms ($r’s > .56$, $p’s < .001$) and negatively correlated with a neuropsychological measure of attention/working memory (WAIS-4 Digit Span, $r’s < -.36$, $p’s < .024$).

• Neither CPT nor SMART-CPT notably decreased pain symptoms

• Pain ratings at baseline moderated decreases in PTSD symptoms - greater pain severity and interference at baseline were associated with poorer treatment response (less of a reduction in PTSD symptoms)

  • These relationships remained significant even when controlling for baseline postconcussive symptoms
**POLYTRAUMA CLINICAL TRIAD**

- Greater pain interference at baseline was also associated with less reduction in postconcussive symptoms from pretreatment to follow-up.
  - This relationship remained significant even when controlling for baseline PTSD symptoms.
- Pain ratings did not, however, moderate cognitive outcomes.
- Pain ratings were also significantly higher in those who dropped out of treatment.
- Similarly, number of sessions attended was negatively correlated with pain severity and pain interference.
Experience of pain in those with a history of concussion may be driven more by depression and pain catastrophizing than by pain intensity, especially in those already prone to overreporting of symptoms (NSI Validity 10).

- Despite no group differences on TBI injury variables.

Pain catastrophizing was a significant predictor of executive functioning, even when controlling for TBI injury variables, gender, pain intensity, depression, and PTSD symptom severity ($\beta = -.020; p = .037$).

- Pain catastrophizing was not a significant predictor of processing speed, learning/memory, or attention.
RETHINKING CONCEPTUALIZATION AND TREATMENT

• Guidelines recommend symptomatic treatment headache, light sensitivity, or even cognition.

• Symptomatic treatments may not completely address the underlying root of the dysfunction but systematic treatments targeting the full constellation of symptoms are lacking.

• Persistent symptoms after concussion are largely influenced by non-neurological factors, with psychological factors as well as environmental stress, and comorbid conditions (e.g., chronic pain, sleep disturbance) contributing significantly to complicated recovery following concussion (McCrea, 2008).
RETHINKING CONCEPTUALIZATION AND TREATMENT

• Somatic Symptom and Related Disorders (DSM-5).
  • Presence of physical or cognitive symptoms that suggest a general medical condition, however are not fully explained by the medical condition and are more fully explained by a mental health condition, and in most cases are not intentionally produced.
  
• Persistent postconcussive symptoms can continue for years following the expected period of recovery
  
• Often out of proportion to the severity of the injury
  
• Often not confirmed on formal medical, functional, or neuropsychological assessment
  

PERSISTENT POST-CONCUSSIVE SYMPTOMS AS A SOMATIC SYMPTOM DISORDER

- In most cases symptoms are not intentionally produced.
- Cogniform Disorder (Delis and Wetter, 2007)
PERSISTENT POST-CONCUSSIVE SYMPTOMS AS A SOMATIC SYMPTOM DISORDER

• Functional cognitive disorder’
  • persistent cognitive symptoms that are inconsistent with objective neuropsychological tests, not compatible with known neurological or medical conditions, cannot be better explained by other diagnoses, cause distress and/or impairment in daily functioning, and do not progress (thought can fluctuate) over time (Pennington, Hayre, Newson, & Coulthard, 2015).
  • 1/3 of those under age 60 who were assessed had medically unexplained or functional cognitive symptoms (Pennington et al., 2015).
  • Almost 75% of those with a history of mild to moderate TBI referred for clinical assessment and treatment of cognitive symptoms had invalid neuropsychological assessments or objective cognitive functioning within normative expectations (Jak et al., 2015).
Within this framework, psychological interventions that target learning to recognize and subsequently break the connections of this negative cycle, hold great promise for this population.
MMPI OF PERSISTENT POST-CONCUSSIVE SYMPTOMS

• 59 consecutively clinically referred Veterans completed the MMPI-2 RF

• 87% scored within the “possible over-reporting” range on one or more validity scales

• Clinical scale elevations were similarly high (T-scores > 65)
  • cognitive (COG; 84.8%)
  • somatic (RC1; 82.6%)

(Jurick et al., under review)
MMPI OF PERSISTENT POST-CONCUSSIVE SYMPTOMS

• Civilian studies using the MMPI-2/MMPI-2-RF scales have demonstrated a “paradoxical effect”

• those with history of concussion have higher elevations on scales thought to measure psychogenic components to physical and somatic complaints such as the Hypochondriasis (Hs), Hysteria (Hy), and RC1 (Somatic Complaints) scales compared to those with moderate to severe TBI (Thomas & Youngjohn, 2009; Youngjohn, Davis, & Wolf, 1997).
MULTIPLE CONCUSSIONS?
REPEITITIVE SUB-CONCUSSIVE BLOWS?
CHRONIC TRAUMATIC ENCEPHALOPATHY?
INCREASED RISK FOR DEMENTIA?
CHRONIC TRAUMATIC ENCEPHALOPATHY (CTE)

• Punch Drunk, Dementia Pugilistica
• CTE terminology arose in the 1940s
• Regained prominent attention with Omalu’s publication on pathology findings of 2 retired NFL players
• Can only be diagnosed definitively with post-mortem neuropath exam
CTE

- Behavior, mood, and memory/cognitive changes prior to death
- Neurofibrillary tangles but less evidence of plaque accumulation, AB plaques not a consistent feature of CTE
- Axonal injury, degeneration, myelinated fiber loss and white matter atrophy - axonal injury likely plays role in initiating the p-tau pathology
CTE

- Mild enlargement of frontal and temporal horns - hippocampal volume inversely related to total years of play
- Prominent perivascular spaces in white matter in temporal lobe
- In more advanced cases, atrophy
CTE

• Has been found in Rugby, Baseball, Soccer, Ice Hockey, football, boxing, domestic violence, chronic head banging
• Cerebellar abnormalities seem unique to boxers
• Disruptions seem most severe at impact locations
• Risk correlates best with total head trauma, both concussive and subconcussive
CTE

• Acceleration-deceleration injury causes tau protein, normally associated with microtubules in axons, to become abnormally phosphorylated, misfolded, aggregated and cleaved

• Generates neurotoxic tau peptide fragments

• How this combo of axonal injury, breach of blood-brain barrier, neuroinflammation develop into progressive deterioration remains to be determined

• Other factors – genetics, gender, physiological stress, environmental exposures
CTE

• No published cross epidemiological or prospective studies
• Current evidence is limited
• Any effect of subconcussive blows is likely to be small and in a select group of individuals

WHILE ALL CTE APPEARS TO RESULT FROM REPETITIVE BRAIN TRAUMA, NOT ALL REPETITIVE BRAIN TRAUMA RESULTS IN CTE.
CONCLUSIONS

• TBI should always be considered and assessed
• Just because someone had a TBI does not automatically mean that should be the focus of treatment if other conditions are more primary
  • Treat the primary condition(s) that explains the most symptoms
• Symptoms that persist beyond the expected period of recovery following concussion are strongly linked to non-neurologic variables
• Reducing emotional distress in Veterans also reduces neurobehavioral symptoms reporting and improves cognitive functioning
• Integrated treatments targeting constellations of symptoms or somatic focus also can be beneficial
CONCLUSIONS

• The evidence that multiple concussions/subconcussive blows can induce neurological changes and raise risk for poor cognitive aging outcomes is not incompatible with the research that indicates comorbid mental health conditions are significant contributors to functional changes and should be the primary target of treatment for persistent post-concussive symptoms.

• Neuropsychologists are optimally suited to bridge this duality