

Blast Overpressure, Acceleration and cognitive Testing in Swift boats (BOATS), an MTBI² Study

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Disclaimers



- Michael J. Roy, MD has no commercial relationships to disclose.
- All members of the research team were trained in protection of human subjects.

This study is funded by the Defense Health Agency, with support for the conduct of the research from the Military Traumatic Brain Injury Initiative (MTBI²) at Uniformed Services University. The authors have no conflicts of interest to disclose. The views expressed in this presentation are solely those of the presenter and do not necessarily represent those of the Uniformed Services University, The Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc., Department of War, or the U.S. government and should not be construed as such. Mention of any commercial product does not connote endorsement.

- **10-15 High-Performance Craft Crewmen (HPCC) training each at different sites:**
 - River with Mini Guns
 - River with Rifles
 - Ocean with Heavy Weapons
 - River with Heavy Weapons
- Exposure measured with both Black Box Biometrics (B3) and Prevent Biometrics (PB) sensors
- Wide array of measures of brain function
- Serial assessments: at baseline, 30-90 minutes, 24 and 96 hours post

Funded by the Military Traumatic Brain Injury Initiative (MTBI²), HU0001-24-2-0051.

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BOATS

**BLAST OVERPRESSURE,
ACCELERATION AND COGNITIVE
TESTING IN HIGH PERFORMANCE CRAFT
CREWMEN**

**ALL HPCC BOAT
OPERATORS/TRAINING
PARTICIPANTS
PLEASE VOLUNTEER**

*Take part in this 1-2 week long study
to assess the impact of
blast overpressure on memory
and other aspects of brain function*

In-person Visits

Baseline → ≤ 1.5 Hour Visit → 24 Hour Visit → 96 Hour Visit

You may be compensated for your participation
*Firing heavy weapons is not required.

For more information contact us
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Site 1: Special Operations Craft–Riverine

- Compact 33-foot aluminum hull
- Crew of 14
- High density of personnel, and weapons
 - M134 Minigun
 - M2 .50 caliber Machine Gun
 - M240 Machine Gun
 - Mk19 Grenade Launcher



SOC-R: High Weapon-Density Platform

Exposure at River Training Site 1 (n=15)

- **River training only, with mini-guns & 50-cals**
- **Range in number of exposures from 1900/day to 11,300/day**
 - **Average of 5000 exposures/day captured, or 20,000 over 4 days**
 - **Median of 4800/day**
- **Cumulative impulse exposure range from 2600 psi-msec/day to 39,700 psi-msec/day (up to 1000X threshold)**
 - **Average: 10,733/day; more than 40,000 over 4 days**
 - **Median: 7100/day, more than 28,000 over 4 days**

Site 2: CCAs and CCMs, Riverine

- **Coastal Craft Assault**
- 41 foot hull
- Somewhat greater dispersal & protection afforded
 - M240 Machine Gun
 - Mk46 & Mk48 Weapon Systems
- **Coastal Command Boat**
- 65 foot hull
- Far greater dispersal & protection afforded
 - M240 Machine Gun
 - Mk19 Grenade Launcher



PB Sensor Data, River Training Site 2

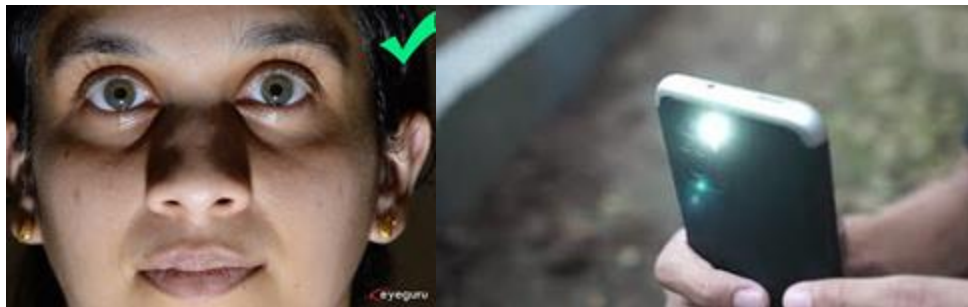
(n=10)

- **River training only, primarily 7.62 mm rifle rounds**
- **4 of 10 with no exposures, only 2 with exposures all 4 days**
- **For the 6 with blast exposure:**
 - **Cumulative impulse ranged from 900 to 4000 psi-msec/day**
 - **Average of 1867 psi-msec/week (4 days)**
 - **This is less than the lowest DAILY exposure at Site 1**
 - **About 30% higher for CCM than CCA, because of greater weapon use and longer time on the water**

Assessments

Retained from INVICTA

- B3 Blast Sensors
- Hopkins Verbal Learning Test—Revised
- AccWalker
- Brain Gauge
- Blood Biomarkers



Novel Assessments

- Vestibular-Oculomotor Survey
- MindMirror pupil response assessment
- Pison Simple Reaction Time and Go/No-Go Test

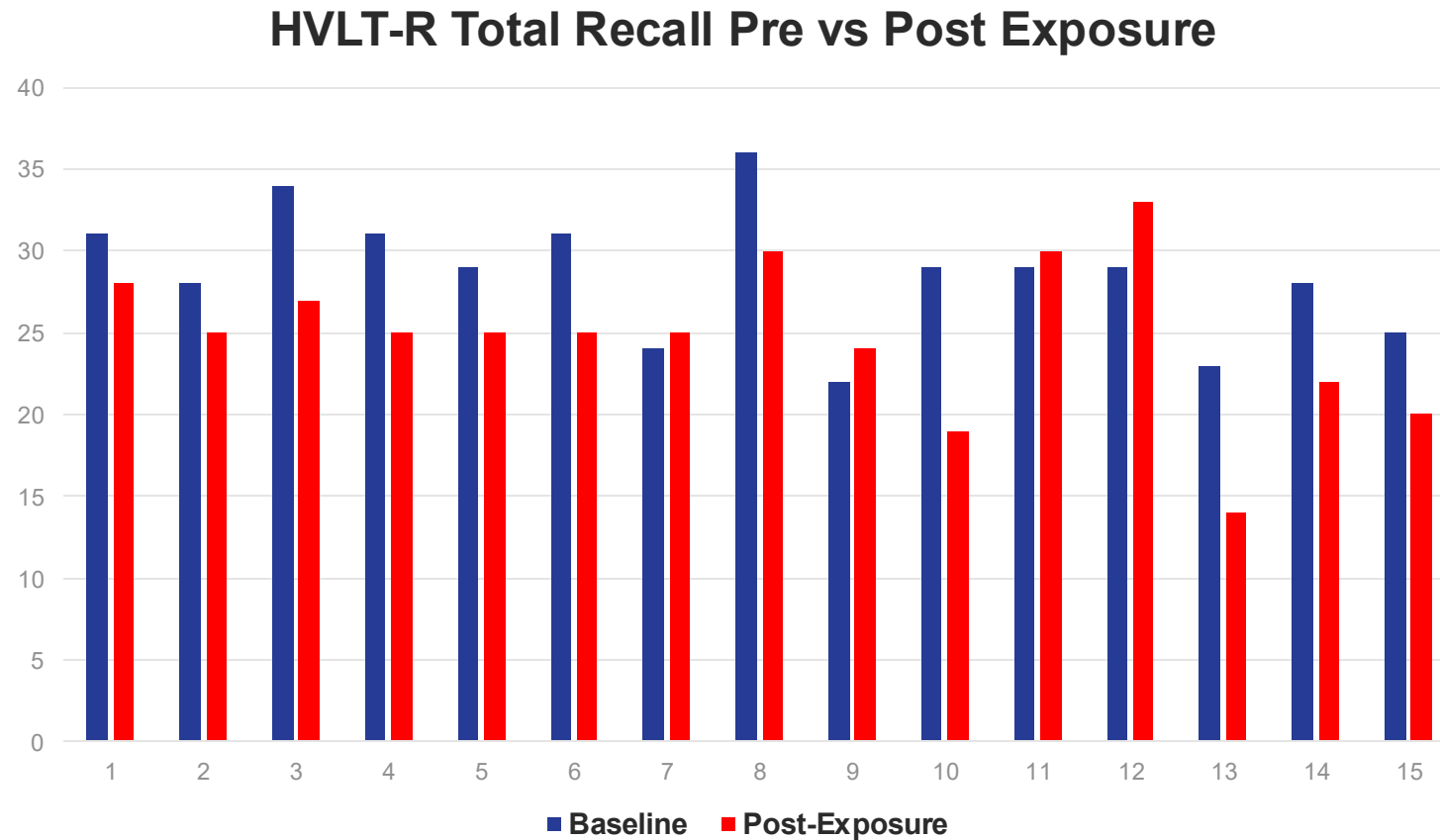


Hopkins Verbal Learning Test-Revised

- 6 different word lists
- 12 words each, in categories such as musical instruments, types of liquor, cooking utensils
- Immediate recall: words repeated 3 times
- Delayed recall: no cues
- Discrimination: 24 words, half on original list



HVLT-R in BOATS Participants



**Average Decline of
3.8 points**

Vestibular Ocular Motor Screening

- **2 of 15 positive at baseline and throughout all assessments; both had increased symptoms (immediately and at 24 hours, respectively)**
- **5 symptomatic immediately post-exposure (40% sensitive overall, including one with magnified symptoms)**
- **All of those still positive at 24 hours, plus 2 more became positive, and one magnified (60% sensitive)**
- **Greatest sensitivity seen at 24 hours**

MindMirror Pupillometry

- **Change in Pupillary Light Reflex (PLR, constriction rate in response to light) demonstrates 83% sensitivity and 79% specificity for exposure**
- **Identifies a threshold for number of exposures and cumulative impulse levels at which risk occurs**
- **High correlation between exposure and PLR, area under the curve of 87% for Maximum Constriction Velocity**
- **Dilation velocity, latency and amplitude also correlate with extent of exposure**

Site 2 Essentially a Control

- **No significant changes in HVLT-R performance**
- **No changes in VOMS**
- **Brain Gauge performance sub-par at Site 1, better at Site 2**
- **Pison assessment yielded no significant changes at either site (both groups improved over time suggesting practice effects greater than blast effects)**
- **Pupillometry Results Pending**

Planned Work

- **Site 3: Heavy Weapons in Ocean Setting**
- **Site 4: Heavy Weapons in River Setting**
- **Should enable comparison of relative impact of high peak pressure/lower cumulative impulse versus low peak pressure/high cumulative impulse, as well as contributions from wave forces**
- **High exposure settings provide an opportunity for assessing effects of interventions**

Conclusions

- **Highly variable exposure depending on what is fired, the frequency of it, the type of boat, and position in the boat**
- **Evidence of significant acute effects on some aspects of brain function in minutes to hours after exposure, but recovery within days**
- **Some are able to complete riverine training without significant exposure**

QUESTIONS ?

The BOATS Team:

- **David Keyser, Coinvestigator**
- **Marcia Dovel, Program Manager & East Coast Lead**
- **Rie Leverett, West Coast Lead**
- **Alexander Hill, East Coast Team**
- **Kenneth-Andres Manlapaz, West Coast Team**
- **Thaddeus Haight, Statistician**
- **Sharon Gibbons, Logistics**
- **Chris Rhea & Josh Lawton, AccWalker analyses**