Use of Environmental Sensor Technologies in U.S. Army Training Environments: Lessons Learned

Tyler Rooks
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Use of Environmental Sensor Technologies in U.S. Army Training Environments: Lessons Learned

In response to the increased prevalence of mild traumatic brain injury (mTBI) diagnoses in the military and athletics, several helmet- or head-mounted environmental sensors (ES) designed to detect and quantify head exposures have been developed by both the Department of Defense (DoD) and commercial entities. These devices offer a seemingly simple technological way to assist in the identification of potentially injurious head exposures; however, they are only starting points. These devices are useful for identifying the level of exposure to the head or helmet; however, they are not capable of determining whether an injury occurred. Furthermore, the military environment presents unique challenges (e.g., tempo, duration, and location) to the development and implementation of ES. To address the challenges of introducing devices capable of monitoring head acceleration exposure into military training, the Military Operational Medicine Research Program developed and funded the Environmental Sensors in Training (ESiT) Research Program.

mild traumatic brain injury, mTBI, environmental sensors, IBPG

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One goal of the ESiT Research Program is to evaluate the ability of available devices to identify potentially concussive events resulting from head acceleration exposures (e.g., impact or inertial motion) occurring in military-training environments.
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The Defense Veterans Brain Injury Center (DVBIC) reported that 449,026 diagnoses of traumatic brain injury (TBI) were made between 2000 and 2021 (82% or 369,675 were classified as mild).\(^1\)

It has been estimated that approximately 80% (295,740) of these diagnoses were made in a non-deployed (garrison) setting.\(^2\)

**Policy**

- Department of Defense (DoD) and Army policy for concussion management in deployed and garrison settings include statements for environmental sensors (ES) as a possible mechanism for identifying potentially concussive events (PCE).\(^3,4\)

**Research**

- In 2013, the White House published the National Research Action Plan (NRAP) for TBI and post-traumatic stress disorder (PTSD) and identified ES as an important research area for identifying PCE.\(^5\)
ESiT Background

- USAARL has been investigating DoD- and commercially-developed devices as tools for identifying potentially concussive events in Army training environments that may involve head impacts with the possibility of injury.
- Training environments included the Basic Airborne Course (BAC) and courses under the Modern Army Combatives Program (MACP).
- Data were collected in support of multiple studies between 2015 and 2018.
- Overall, data were collected from 160 participants over 13 classes.
- Participants from both training environments were instrumented with multiple devices.
- A minimum of two devices were used for every participant.
ESiT – Targeted Environments

Training Environments
- **Blast**: Grenade throwing, breachers, artillery, shoulder-fired weapons, etc.
- **Blunt**: Combatives/boxing, airborne training

Athletics and Service Academies (e.g., U.S. Military Academy [USMA])
- Combatives/boxing and rugby

* Breachers*:

* Artillery:
- https://www.army.mil/article/79935/Picatinny_engineer_pursues_improved_hand_grenade
ESiT – Process for Selecting ES

- Independent laboratory testing to ensure that the addition of the ES would do no harm to the trainees and/or cadre and to evaluate the performance of the sensors.

- Screen a selection of ES through an initial form/fit/ergonomics/human factors evaluation with leadership and cadre at the targeted training environments:
  - Combatives
  - Boxing
  - Airborne
  - Sports
  - Blast

- Obtain a U.S. Army Evaluation Center Safety Release.

- Screen and evaluate a selection of ES through small-scale studies with active training classes.
ESiT – Sensor Technologies and Selection

- Current/Future use of ES in the DoD as part of ESiT:
  - Both blunt and blast environments
  - Garrison training environments versus deployed environments
- Many sensors are available on the market.
- For blunt impact and accelerative exposures, few were developed for the military, specifically.
- Sensors provide different types, amounts, and quality of data.
- The variation in data limits the translatability of a dose-response relationship from one sensor to another.

Note. Sensor details (name, manufacturer, etc.) are intentionally unidentified throughout the presentation.
ESiT – Lessons Learned

1. Human factors and interaction
2. Device administration
   1. Battery life
   2. Logistics
   3. Data management
3. Device performance
   1. Distinguishing between real and false data
   2. Sensor to sensor variability
4. Environment and training
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*Parachute Landing Fall (PLF)
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![Results – Peak Linear Acceleration of the Head CG](image)
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<table>
<thead>
<tr>
<th>Training Lane</th>
<th>Airborne</th>
<th>Combatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>• Outdoors</td>
<td>• Conducted in a gym</td>
</tr>
<tr>
<td>Extremes</td>
<td>• Throughout year (seasonal extremes)</td>
<td></td>
</tr>
<tr>
<td>Tempo</td>
<td>• Drills all day</td>
<td>• Less than half-day drill session (approximately one hour)</td>
</tr>
<tr>
<td></td>
<td>• Breaks between drills</td>
<td>• Majority of Soldiers engaged through entire session</td>
</tr>
<tr>
<td></td>
<td>• Lunch break</td>
<td></td>
</tr>
<tr>
<td>Personal</td>
<td>• Standard ACU uniform</td>
<td>• Standard ACU uniform (no boots)</td>
</tr>
<tr>
<td>Protective</td>
<td>• ACH helmet</td>
<td></td>
</tr>
<tr>
<td>Equipment</td>
<td>• Jump Kit specific to the current drill</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Full harness and parachute</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Training harness</td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td>• Safety Release required for all equipment</td>
<td>• Safety Release required</td>
</tr>
<tr>
<td></td>
<td>• Compatible with required PPE</td>
<td>• Compatible with required PPE</td>
</tr>
<tr>
<td></td>
<td>• Compatible with harness/parachute/jump kit</td>
<td>• Cannot degrade PPE performance</td>
</tr>
<tr>
<td></td>
<td>• Cannot degrade PPE performance</td>
<td>• Sanitation</td>
</tr>
<tr>
<td></td>
<td>• Sanitation</td>
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</tr>
</tbody>
</table>
Available as a Multimedia Resource Document (MMRD)

Take-Home Message

1. Managing time-synchronization across platforms, data collection tools, exercise events, and notes is paramount and not trivial.

2. Sensors provide different types, amounts, and qualities of data, and the variation in data limits the comparability across sensors and studies.

3. Environmental sensors are usable and important for quantifying exposure conditions that may lead to neurotrauma.

4. Environmental sensors should not be used blindly in research programs quantifying exposure conditions that may lead to neurotrauma.
Questions?

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References


All of USAARL’s science and technical information documents are available for download from the Defense Technical Information Center.

https://discover.dtic.mil/results/?q=USAARL