Blast Exposure and TBI in the Veteran Population: Effects on Central Auditory Processing

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Blast Exposure & TBI among Veterans

- From 2000 to 2016: 361,092 military personnel diagnosed with TBI\(^1\)
  - 82.3% classified as mild
  - 22% of all combat casualties resulting from TBI

- Many more have been exposed to high-intensity blast waves\(^2\)
  - Even without TBI diagnosis, is sufficient to cause premature brain aging, white matter damage, and chronic symptoms\(^3\)

\(^1\) Defense and Veterans Brain Injury Center, 2017
\(^2\) Institute of Medicine Report, 2013
\(^3\) Trotter et al. (2015) Military blast exposure, ageing and white matter integrity
Common hearing-related complaints of blast-exposed Veterans:

- Hearing in noise
- Following rapid speech
- Understanding spoken instructions
- Following long conversations
- Tinnitus
- Hyperacusis
Case Study

• Male Veteran, age 52 at first visit
  – Referred to **Auditory Processing Disorder** clinic by general audiology clinic

• Auditory Complaints:
  – Difficulty hearing in noise & in presence of multiple talkers
  – Difficulty on the telephone
  – Difficulty paying attention to people speaking
  – Confusion of similar sounding words
  – Talks louder than normal
  – Needs TV louder than normal
Medical History

• **Diagnosed with TBI** stemming from blast exposure from IED in 2008
  – 2 additional blast exposures as well

• Previously undergone Cognitive Rehabilitation treatment in Polytrauma/SLP for cognitive difficulties

• Additional medical diagnoses including:
  – PTSD
  – Obstructive Sleep Apnea
  – Chronic Headaches
  – Diabetes Mellitus, Type-2
  – Colitis
  – Obesity
  – Nerve compression of arm leading to weakness and numbness
  – Chronic back pain
  – Chronic knee pain
  – Hyperlipidemia
  – Coronary heart disease
Routine Audiometry

- Normal pure tone thresholds:
- Normal middle ear and tympanic membrane function
- Normal acoustic reflexes
- Normal inner ear function (DPOAEs present from 750 – 8000 Hz)
- Excellent speech recognition in quiet
APD Test Measures

• SCAN-A (all subtests)
  – Filtered Words
  – Auditory Figure Ground
  – Competing Words
  – Competing Sentences

All Normal

• Temporal Processing: Gaps-in-Noise
  – Right ear
  – Left ear

Thresholds of 8 to 10 ms in each ear = Abnormal

• Temporal Pattern Recognition: Pitch Pattern Test
  – Right Ear 52% Correct = Abnormal
  – Left Ear 80% Correct = Abnormal
APD Test Measures cont.

• Speech Understanding in Noise Tests:
  – Words-in-Noise (WIN)
  – QuickSIN

\[\text{Normal Performance}\]

• Dichotic Listening Tests Digits
  – Dichotic Digits Test
  – Staggered Spondaic Words Test

\[\text{Normal Performance}\]
Research on Chronic Effects of blast exposure

**Participant Stats:**

- Blast-exposed within the past 10 years (n=30)
- Normal or near normal hearing thresholds
- Average age of 37 (range: 25 – 64)
- All had excellent speech understanding in quiet
- N = 29 age- and hearing-matched controls

~40% of Blast-exposed group “abnormal” on ≥ 2 tests

• **Spatial Release from Masking – Speech**
  – How much benefit does the listener gain from having spatial separation between target voices and distractions?

  - Control listeners achieve an average spatial release of ~10 dB (SD: 2.6 dB)

  **Case Study Patient:** 3 dB Spatial Release
Electrophysiological Data

- Cortical Gaps-in-Noise paradigm corroborated behavioral results:

- Cortical detection of ITD cues corroborated behavioral SRM results
P300 oddball paradigm

- 500 Hz “standard” tone (80% of trials)
- 1000 Hz “rare” tone (20% of trials)
Clinical Impressions & Recommendations

• Impressions:
  – Temporal processing impairment
    • Likely contributes to perceived difficulty with speech understanding in noise:
      – Minimal benefit from spatial separation of sound sources
      – “Smearing” of sounds over time

• Recommendations:
  – Low-amplification hearing aids with directional microphones & FM system
  – Counseling re: environmental modifications and communication strategies to improve SNR
Follow-Up

- Data Logging indicates average hearing aid use of 8 hours per day.

- He overall finds the hearing aids to be "perfect." He stated that the hearing aids have made a huge, positive difference in his daily life.

- Reports that he is less fatigued by the end of the day, because it is easier to hear.

- He also reported a significant improvement in his ability to understand in background noise and on the telephone.

- Family has also noticed a great improvement.

- 2 years later, Veteran is still wearing HAs regularly.
What interventions are most effective?

Research by Gabrielle Saunders, Terry Chisolm, and Paula Myers

Participants (n = 86):
- OEF/OIF Veterans
- Normal or near normal hearing thresholds
- Blast exposure incurred during deployment (since 2001)

Interventions (4 groups):
- FM System
- Auditory Training (Posit Brain Fitness program)
- FM System + Auditory training
- Counseling only
Generally, the greatest improvements were found for the FM and the FM+AT groups with minimal change in the AT group.
Compliance with Intervention

Auditory Training

<table>
<thead>
<tr>
<th>% participants</th>
<th>&lt;25%</th>
<th>25-49%</th>
<th>50-74%</th>
<th>75-100%</th>
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<tr>
<td>n</td>
<td>37</td>
<td>1</td>
<td>25</td>
<td>7</td>
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Percentage of Auditory Training Completed

FM System

<table>
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<tr>
<th>Frequency</th>
<th>Participants</th>
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</thead>
<tbody>
<tr>
<td>None</td>
<td>1</td>
</tr>
<tr>
<td>Hardly Ever</td>
<td>13</td>
</tr>
<tr>
<td>Few Times/Week</td>
<td>25</td>
</tr>
<tr>
<td>Everyday</td>
<td>7</td>
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Many thanks to our **Veterans** and to all those that made this work happen!!!

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