Hearing Difficulties Associated with Traumatic Brain Injury

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Outline

Background
• The Ear & Hearing Testing

Impact of TBI on the Ear and Hearing

TBI-Induced Hearing Difficulties: A Case Study

Current Research
The Ear & the Auditory System
The Ear & the Auditory System
Impact of TBI on the Ear and Hearing

- Hearing Loss
- Tinnitus & Sound Sensitivity
- Dizziness / Imbalance
- Hearing Difficulty “Hidden Hearing Loss”
Impact of TBI on the Ear:
Hearing Loss Due to Temporal Bone Fracture

Longitudinal Fracture (70-90%)
• Observable injury to the middle ear
• Results in a conductive hearing loss

Transverse Fracture
• Observable injury to the inner ear
• Results in a sensorineural hearing loss
Impact of TBI on the Ear:  
**Tinnitus**

Tinnitus = Sensation of sound in your ears when no external sound is present.

**Causes:**
- Loud sound/noise
- Aging
- Head injury
- Medication
- Build up of earwax

**Negative Consequences:**
- Sleep disruption
- Inability to concentrate
- Stress, anxiety, depression

**Treatment? ABSOLUTELY!**
- Sound therapy
- Hearing aids
- Counseling and meditation

Impact of TBI on the Ear: Sound Sensitivity

**Hyperacusis** = Abnormal sensitivity to sounds resulting in pain or discomfort.

Example: the brain’s auditory system is turning up the volume – so a loud sound really is louder to the individual.

**Causes:**
- Loud sound/noise
- Head injury
- Medications
- Infections

**Negative Consequences:**
- Sleep disruption
- Inability to concentrate
- Stress, anxiety, depression

**Treatment? ABSOLUTELY!**
- Sound therapy
- Hearing aids
- Counseling and meditation

Impact of TBI on the Ear: Dizziness & Imbalance

**Balance** = Maintained using sensory information from 3 systems:
- Vision
- Proprioception (muscles & joints)
- Vestibular – or inner ear

**Vestibular Causes of Dizziness or Imbalance:**
- Head injury
- Aging
- Medications
- Infection

**Negative Consequences:**
- Dizziness and Imbalance/unsteadiness
- Vertigo
- Nausea
- Lack of coordination

**Treatment? ABSOLUTELY!**
- Balance (vestibular) rehabilitation therapy
- Vision therapy
- Medications
- Diet & lifestyle changes
- Surgery
Impact of TBI on the Ear: Hearing Difficulties, or “Hidden Hearing Loss”

Injury to the areas of the brain responsible for processing speech, resulting in:

- **Difficulty understanding speech**
  - Noise, reverberation, visual distractions, etc.

- **Effortful listening**
  - Increased effort for challenging tasks and slower processing
  - Resulting in stress and fatigue
Impact of TBI on the Ear: Hearing Difficulties, or “Hidden Hearing Loss”

- Experience reductions in quality of life & poorer psychosocial functioning;
- Higher rates of depression & emotional distress
- Perceived symptoms warrant help-seeking behavior
- Self-refer for hearing or medical evaluations;
- Diagnosed as having ‘normal hearing’ without further specialized hearing testing.
- Like speech-in-noise
Impact of TBI on the Ear: Hearing Difficulties, or “Hidden Hearing Loss”

How often does this happen?

- 16% of children with a history of mild to severe TBI
- 63% of athletes with a history of concussive injury
- 58% of adults 7-11 years post-head injury
- 39% (quiet) and 78% (noise) of blast-exposed Veteran’s
TBI-Induced Hearing Difficulties: A Case Study

Case History
- 58-year-old female
- mTBI due to an MVA
  - No LOC or AOC
  - Brain and spine CT were normal

Auditory Symptoms
- Sensitivity to loud sounds
- Tinnitus
- Difficulty understanding speech in noise

Other Symptoms
- Cognitive (memory difficulties, loss of concentration)
- Visual (light sensitivity, blurred vision)
- Vestibular (dizziness, balance issues)
- Physical (headaches, insomnia)
- Emotional (anxiety, fear of driving)
TBI-Induced Hearing Difficulties

Patient Report

• Inability to attend church & family events
• Difficulty hearing in a restaurant setting
• Difficulty in groups due to perception of sounds being too loud
• Considerable emotional distress related to her growing isolation – stated she had been “robbed of life”

Hearing Evaluation Results?

• All standard tests of hearing were NORMAL!
TBI-Induced Hearing Difficulties

Specialized Tests of Auditory Processing

- Poor performance for:
  - Speech-in-Noise, especially without contextual cues
  - Competing Speech
  - Temporal Processing

Now the test results match the patient’s perception!
TBI-Induced Hearing Difficulties

**Treatment**
- Mild-gain hearing aids
- Use: 12-14 hours a day

**Patient Perceptions**
- Substantial improvement listening in noise
- Following conversations was easier!
- Found loud sounds tolerable
- Attending meetings by 4-weeks

Hearing aids allow her to participate in activities she previously enjoyed.

Describes herself as “deaf in background noise” without her hearing aids.
My Current Research

**Purpose:**
- To evaluate *hearing difficulty* (HD) using measures of *binaural* auditory processing in adults with a history of TBI.
<table>
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<th>Group 1 (CONTROL):</th>
<th>Group 2 (TBI):</th>
<th>Group 3 (TBI HD):</th>
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<tbody>
<tr>
<td>n = 32</td>
<td>n = 20</td>
<td>n = 11</td>
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<tr>
<td>Age: 19-57 years</td>
<td>Age: 20-33 years</td>
<td>Age: 25-63 years</td>
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<tr>
<td>No history of mTBI</td>
<td>Positive history of mTBI</td>
<td>Positive history of mTBI</td>
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<tr>
<td>No hearing difficulty</td>
<td>No hearing difficulty</td>
<td>Positive self-perceived hearing difficulties</td>
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<tr>
<td></td>
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<td>Based on questionnaire responses</td>
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Preliminary Questionnaire Responses

Hearing Handicap Inventory for Adults

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<th>Participant Group</th>
<th>HHIA Score</th>
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<tr>
<td>Control</td>
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<tr>
<td>TBI</td>
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<tr>
<td>TBI HD</td>
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Adult Auditory Performance Scale

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<th>Participant Group</th>
<th>AAPS Global Score</th>
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<tr>
<td>Control</td>
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<tr>
<td>TBI</td>
<td>2</td>
</tr>
<tr>
<td>TBI HD</td>
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Summary: Preliminary Results

Speech-in-Noise
- Performance was poorer without ‘extra cues’, like differences in talker and sound sources

Competing Words
- Poorer ability to recognize competing stimuli when the cognitive load is high.

Tone Detection in Noise
- Poorer ability to make use of timing/phase cues
Group Results: Speech-in-Noise

Better performance

Significant effect of GROUP (p < .05)
Group Results: Competing Speech

Significant effect of GROUP (p < .05)
Group Results: Tone in Noise Detection

Better performance

Significant effect of GROUP (p < .05)
Results: Listening Effort

TBI participants experienced significantly greater degrees of ‘listening effort’ than the Control Groups.
Conclusions

1. TBI can negatively impact many aspects of auditory/hearing function.

2. Adults with a history of TBI and hearing difficulty may experience significantly greater degrees of ‘listening effort’.

Take Aways:
- Not all adults with a history of TBI experience Hearing Difficulty or other hearing-related symptoms;
- For those that do, effective treatments are available!
Thank you!

Questions?

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https://sphs.osu.edu/clinic
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