DEVELOPMENT OF A SCREENING TOOL FOR AUDITORY PROCESSING DEFICITS AFTER TBI

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What is Auditory Processing?

- *How the brain reconstructs and makes “sense” of sounds waves that are broken down and encoded in the cochlea*

- Encompasses a WIDE range of processing, such as:
  - Stream segregation and binaural comparisons
  - Auditory discrimination and recognition
  - Auditory memory and sequencing

- *Symptoms of auditory processing deficits may include:*
  - Mishearing or misinterpreting words or speech patterns
  - Difficulty understanding speech in the presence of other sound sources
  - Problems keeping up with conversations, especially with multiple talkers
  - Problems recalling spoken information
  - Difficulty understanding rapidly spoken or accented speech
  - Easily fatigued by listening
  - And more!
Challenges in Auditory Processing Disorder (APD) Assessment

- Similar symptoms/complaints may be caused by different underlying deficits
  - E.g., speech in noise difficulties

- Auditory processing outcomes of patients with previous mTBI are heterogenous
  - E.g., patients with blast-related mTBI can have deficits in very different domains of auditory processing
  - Not everyone with an mTBI develops chronic auditory difficulties

- Full evaluation of auditory processing abilities is time consuming and requires specialist audiological care

The Goal:

- Develop a screening test for APD in patients with previous TBI:
  - Determine which patients are likely to fail a diagnostic APD test battery
  - Point towards possible domains of processing weakness to better focus diagnostic protocols
  - Should be fast, repeatable, and able to be administered by non-specialists
Time Compressed Digits Test

Normal Speaking Rate
“108 – 9079”

Waveform

Spectrogram

108 ****

1 2 3

4 5 6

7 8 9

ACCEPT 0 << CANCEL
Time Compressed Digits Test

Normal Speaking Rate
“108 – 9079”

Compressed to 1/5 original length

Compressed with silent gaps inserted

- Measured with & without background noise
- Scored with both “strict” and “lax” methods

- How long of a silent gap is needed to “recover” the speech information?
Why Time Compressed Digits?

- Targets several domains of Auditory Processing:
  - Temporal acuity
  - Temporal pattern recognition and recall
  - Monaural low redundancy
  - Auditory processing speed and information recovery
  - Speech-in-noise understanding

- Also repeatable, low language requirements, ecologically valid, automated administration
Pilot: Methods & Hypothesis

Participants (all normal hearing sensitivity):
- Previously diagnosed mTBI (n = 36)
  - Avg. age: 35.7 years (range: 23 to 50)
  - Borderline or abnormal performance on ≥1 APD test
- Control participants (n = 26)
  - No history of head injury or blast exposure
  - Must pass all APD tests
  - Age- and sex-matched with TBI participants

Procedures:
- Battery of 8 clinical diagnostic APD tests
- 16 TCD Conditions:
  - Quiet and Noise presentations of: Uncompressed and compressed digit strings with gap durations of 0, 20, 40, 80, 120, and 160 ms, and an Aperiodic gaps condition

Hypothesis: The conditions that will best separate participants with and without auditory processing deficits will be Compressed Digits with 40 ms gaps presented in background noise
Results

TCD Performance w/Strict Scoring (%)

- Control
- mTBI

Percent Correct

Normal Rate 0 ms 20 ms 40 ms 80 ms 120 ms 160 ms Aperiodic

TCD Condition

$p = .047$ $p = .028$
Results

TCD Performance w/Strict Scoring (%)

Percent Correct

Normal Rate 0 ms 20 ms 40 ms 80 ms 120 ms 160 ms Aperiodic

TCD Condition

Number of APD tests Failed

Percent Correct

$R^2 = 0.4095$

$p = 0.003$

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Results

Compressed with 160ms gaps in Noise
- ROC based upon mTBI participants only
- Area Under the Curve (AUC) = 0.829!

<table>
<thead>
<tr>
<th>Cut-off Score</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>90% Correct:</td>
<td>0.800</td>
<td>0.750</td>
</tr>
<tr>
<td>86% Correct:</td>
<td>0.867</td>
<td>0.563</td>
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</tbody>
</table>
Conclusions

- Compressed digits with 160 gaps presented in background noise does an excellent job of detecting who is and is not likely to fail an APD test battery!

- Proves again that it’s often the conditions that are easy for control participants and slightly harder for patients that are most sensitive to deficits!

Further Analyses and Future Plans

- Explore whether specific patterns of performance or scoring are correlated with specific types of auditory processing deficits

- Apply TCD test to a wider population to determine whether results hold up
  - More patients with previous mTBI
  - Do these results apply to patients with APD from non-TBI causes?
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