INTRODUCTION

• Speech processing by a cochlear implant (CI) can be simulated with a channel vocoder (Shannon et al., 1995).
• Numerous vocoder studies have been performed to understand CI and simulated CI speech perception.
• In many cases, adults show a period of adaptation (i.e., learning) to vocoded speech.
• Vocoder stimuli have been used in developing speech understanding experiments in children (Eisenberg et al., 2000).
• It is unclear if adults and children learn vocoded speech at different rates. If they learn vocoded speech at different rates, then interpreting results for vocoded speech understanding experiments with children will be confounded whether listeners were trained or not.

HYPOTHESIS

• Children and adults will adapt to/learn vocoded speech.
• Vocoders have been used in speech understanding experiments in children (Eisenberg et al., 2000).
• Speech processing by a cochlear implant (CI) can be simulated with a channel vocoder (Shannon et al., 1995).

METHODS

• Stimuli: Target Talker (spoken by a male)
  - Level = 65 dB SPL (A)
  - Background Talkers (two female talkers speaking nonsense)
  - Talkers and listeners were colocated (no spatial separation)
  - Target and background talkers were added together, then processed with an 8-channel vocoder

• Conditions: Signal-to-noise ratio (SNR): Quiet, +10, +5, +0

• Design: Test listeners for 2 sessions of 2 hours
  - Correct answer feedback after each trial
  - 20 runs tested in total for Adults
  - 15 runs tested in total for Children

• Analysis: Calculated percentage of correct words (Pc) as a function of run number

WORDS

Stimuli
  - Consonant-Nucleus-Consonant (CNC) 50 phonetically balanced (CVC) words (list phonetically balanced to increase word number of confusions)

Method
  - Ten words were played at random at each of the four different SNRs (40 trials per run in total)
  - Choose answer from display of 50 words

• Bits and children clicked responses themselves, but children were supervised.
• 10 Adults (>18 years old)
• 8 Children (8-10 years old)
• All had normal hearing thresholds

Figure 1: Testing screen consisting of 50 CNC words.

Figure 2: Pc as a function of run number for words. Different SNRs are plotted in each panel. Data is shown for 10 adults and 8 children.

Table 1. Rate of improvement for words at different SNRs.

<table>
<thead>
<tr>
<th>SNR (dB)</th>
<th>Initial Pc</th>
<th>Adult</th>
<th>Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet</td>
<td>1.76</td>
<td>0.46</td>
<td>0.52</td>
</tr>
<tr>
<td>+10</td>
<td>1.68</td>
<td>0.54</td>
<td>0.68</td>
</tr>
<tr>
<td>+5</td>
<td>1.98</td>
<td>0.62</td>
<td>0.73</td>
</tr>
<tr>
<td>+0</td>
<td>2.22</td>
<td>0.68</td>
<td>0.76</td>
</tr>
</tbody>
</table>

SENTENCES

Stimuli
  - IEEE Sentences with 5 keywords per sentence

Method
  - Type “What you hear” in an answer box
  - Five sentences were played at random at each of the different SNRs (20 trials per run in total)
  - Participants never heard the same sentence twice

• Adults have a faster improvement rate than children
• 6 Adults (>18 years old)
• 2 Children (8-10 years old)
• All had normal hearing thresholds

Figure 3: Acute adult and children results (run 1) for sentences are compared to trained adult and children results (average over last 5 runs).

Table 2. Rate of improvement for sentences at different SNRs.

<table>
<thead>
<tr>
<th>SNR (dB)</th>
<th>Initial Pc</th>
<th>Adult</th>
<th>Children</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet</td>
<td>100</td>
<td>100</td>
<td>20.0</td>
</tr>
<tr>
<td>+10</td>
<td>90.8</td>
<td>93.6</td>
<td>25.0</td>
</tr>
<tr>
<td>+5</td>
<td>86.8</td>
<td>14.0</td>
<td>30.0</td>
</tr>
<tr>
<td>+0</td>
<td>84.0</td>
<td>12.0</td>
<td>35.0</td>
</tr>
</tbody>
</table>

Figure 4: Testing screen: Consists of a “Sentence” box where the participant types their response. The correct answer appears in the “Answer” box after the participant enters a response.

Figure 5: Pc as a function of run number for sentences. Different SNRs are plotted in each panel. Data is shown for 6 adults and 2 children.

Figure 6: Acute adult and children results (run 1) for sentences are compared to trained adult and children results (average over last 5 runs).

Figure 7: Comparison of trained results: Adult vs Child and Words vs Sentences.

Figure 8: Comparison of acute results: Adult vs Child and Words vs Sentences.

Conclusions

1. Adults and children both show improvement with training (Figs. 2, 3, 5, 6).
2. Children have a faster improvement rate (Tables 1 and 2), but adults maintained a better overall performance (Figs. 3, 6, 7, 8).
3. Arguments against development difference in processing spectrally degraded speech.
4. Performance for sentences was higher than words at high SNRs, but lower at low SNRs.
5. Due to contextual cues?
6. Testing will continue until data is collected for 10 listeners in each group.

REFERENCES