Non-simultaneous Masking of Speech in Noise: Normal-Hearing Children and Adults

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BACKGROUND

Previous psychophysical experiments have demonstrated that children have immature temporal processing when compared to adults for forward and backward masking tasks1,2. Forward Masking Forward masking occurs when a noise precedes a signal. Thresholds in this condition are influenced by both peripheral (e.g., “ringing” of the basilar membrane) and central effects (e.g. difficulties differentiating the signal from the masker). Backward Masking Backward masking occurs when a signal precedes a noise. The mechanisms of backward masking are unclear but thought to be entirely central, not peripheral.

Children perform poorly in measures of forward masking and even more poorly in measures of backward masking when compared to adults. Previous studies have used unnatural stimuli, typically tones or noise. The purpose of this study was to quantify the amount of forward and backward masking children experience as compared to adults for speech, an ecologically valid stimulus.

METHODS

Participants
Normal hearing listeners ages 5-10 and 18-35 years participated in the study.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean Age (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>19</td>
<td>7.2 (1.3)</td>
</tr>
<tr>
<td>Adults</td>
<td>20</td>
<td>24.7 (4.0)</td>
</tr>
</tbody>
</table>

Table 1. Mean age and standard deviation (SD) of child and adult participants.

Test Procedure
Participants heard CVC non-words2 in between two bursts of speech shaped noise (200ms duration, 5ms raised cosine ramps). Stimuli were presented monaurally via headphones and participants were asked to repeat each word. The masker was always presented at 70 dB SPL. Target words were presented for all listeners at a fixed level of -30 dB SNR.

In addition, 50% correct performance was estimated for adults using a 1-down, 1-up procedure. These data were used to estimate the SNR required for adults to have child-like performance.

Video recordings of each session were phonetically transcribed to analyze error patterns.

RESULTS

Fixed Level Performance

<table>
<thead>
<tr>
<th>Phoneme</th>
<th>C1</th>
<th>V</th>
<th>C2</th>
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<tbody>
<tr>
<td>RAU</td>
<td>64.5</td>
<td>110.1</td>
<td>80.1</td>
</tr>
<tr>
<td>Auditory</td>
<td>43.5</td>
<td>51.3</td>
<td></td>
</tr>
<tr>
<td>Children</td>
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Figure 1. Fixed level performance for adults and children at -30 dB SNR.

Psychometric Functions for Adults

Figure 2. Psychometric functions were fitted to adult data obtained using the adaptive threshold procedure. The goal was to estimate the SNR corresponding to children’s performance with a -30 dB SNR stimulus (43.5% for C1 and 51.3% for C2). Those levels were 41.3 dB and 45.8 dB SNR, respectively.

Error Patterns

Figure 3. Error patterns for adults and children at -30 dB SNR for the 1st consonant (forward masking), vowel, and 2nd consonant (backward masking).

Table 2. Results of ANOVA comparison

FUTURE DIRECTIONS

Future studies could determine if the results generalize to real speech materials, though this would introduce linguistic confounds and make it difficult to measure perceptual processing ability alone.

Further research could also assess older children to better understand how the developmental trajectory of temporal processing continues.

Finally, spatial separation of the target signal and masker would more closely simulate real world listening and provide insight into the benefit this cue may provide for non-simultaneous masking.

ACKNOWLEDGEMENTS

This work is supported by NIH NIDCD R01-DC014480. The authors would like to thank Hannah Hodsen, Margaret Miller, Heidi Lang, Kevin Yu, Jessica Mitchell and Connelly Crowe.

REFERENCES