Effect of Noise upon the Perception of Speech Intelligibility in Dysarthria

Megan J. McAuliffe1, Martina C.M. Schäfer1, Greg A. O’Beirne1, Leonard L. LaPointe2
1University of Canterbury, Christchurch, New Zealand
2Florida State University, Tallahassee, USA

BACKGROUND
• Recent studies in dysarthria have examined the role of the listener in the communication process [1-2]; though listening has been examined under optimal conditions.
• In daily life, events occur in sub-optimal listening conditions – noise may negatively affect a listener’s ability to process the speech signal during communication exchange.
• Normal speech intelligibility is adversely affected by noise [3], with greater effects observed when speech is artificially distorted by time compression and reverberation [4].
• Preliminary research has further indicated that dysarthric and normal speech may be differentially affected by background noise [5]. Further examination of this potential effect is required.

RESEARCH QUESTION
• Is the intelligibility of dysarthric speech, at word and phrase-level, affected similarly to normal speech when presented in noise? It is hypothesised that dysarthric speech will show greater declines in intelligibility with increased noise than normal speech.

METHOD
• Listeners: Twenty undergraduates, 19 females and 1 male with a mean age of 20 years (SD= 2.5 years).
• Procedure: Two experiments were conducted with order counterbalanced across listeners: (1) Word level intelligibility using a forced choice paradigm (four choices) and (2) Phrase level intelligibility via orthographic transcription.
• Both experiments included four conditions: no noise (NN); +6 dB signal-to-noise ratio (SNR); 0 dB SNR; and -3 dB SNR. Listeners completed the task in a quiet room while wearing high-quality headphones. Presentation order was blocked to ensure that no listener heard the same stimuli more than once.
• Noise: Multi-talker babble was presented in conjunction with the speech stimuli.

RESULTS
• Significant main effects were observed for Group (F=22.87, p<0.001) and Condition (F=8.71, p<0.001), and a significant interaction (F=0.55, p=0.65).

METHOD CONT
• Speech stimuli: Obtained from three adult males with dysarthria and three age-matched controls (see Table 1). Stimuli collected included: (1) 72 words from the single-word intelligibility test of Kent et al. [6] and (2) Phrases derived from the Assessment of Intelligibility of Dysarthric Speech.
• Reliability: Mean intra-participant reliability was calculated for word intelligibility data. Twenty percent of the data set was repeated. Results indicated that r=.51, p<0.001. Inter-listener reliability was 0.73 (Cronbach’s alpha). Statistical Analysis
• Procedures: Two mixed between-within subjects ANOVAs were conducted to explore the effects of speaker group (dysarthric versus control) and noise condition (no noise, +6 dB SNR, 0 dB SNR, and -3 dB SNR) upon intelligibility in the word-level and phrase-level experiments. Post hoc analysis was conducted using pairwise multiple comparisons.

Table 1: Characteristics of the dysarthric speakers.

<table>
<thead>
<tr>
<th>Speaker</th>
<th>Age</th>
<th>Time post-injury</th>
<th>Dysarthria diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>58</td>
<td>39</td>
<td>Severe spastic-ataxic</td>
</tr>
<tr>
<td>2</td>
<td>52</td>
<td>32</td>
<td>Moderate ataxic</td>
</tr>
<tr>
<td>3</td>
<td>35</td>
<td>16</td>
<td>Moderate-severe spastic-flaccid-ataxic</td>
</tr>
</tbody>
</table>

Figure 1: Percent correct, single word forced choice.

RESULTS CONT
• Significant main effects observed for Group (F=104.42, p<0.001) and Condition (F=138.61, p<0.001), and a significant interaction (F=19.60, p<0.001).
• Primary post-hoc finding: A significant reduction in intelligibility between the NN and +6 SNR condition for the group with dysarthria (t=6.81, p<0.001).

DISCUSSION
• Results confirm prior research suggesting that listeners’ perceptions of speech intelligibility in dysarthria is affected differently to normal speech when presented in noise [9].
• At phrase level, the intelligibility of dysarthric speech was adversely affected compared to normal speech in relatively low noise conditions (i.e., +6 SNR). Therefore, it is likely that speakers with dysarthria are required to significantly increase their effort levels when communicating in sub-optimal listening environments.
• Future research should aim to examine the underlying reasons for the differences in effects upon the listener in noise – e.g., contributions of acoustic parameters and cognitive linguistic processing.
• Investigation of speaker adaptation to differing acoustic environments is also required.

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REFERENCES