Influence of Auditory Distraction upon Intelligibility Ratings in Dysarthria

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BACKGROUND
- Intelligibility of non-disordered speech is known to be adversely affected by background noise [1-3].
- Research has not yet considered how auditory distraction, in the form of background noise, affects the intelligibility of dysarthric speech.
- Listeners attempt to comprehend dysarthric speech in a multitude of environments. Therefore, research examining the effects of noise upon speech intelligibility in dysarthria may inform the development of facilitative strategies aimed at enhancing listener comprehension.

RESEARCH QUESTIONS
- Is the intelligibility of dysarthric speech affected similarly to normal speech under conditions of auditory distraction?
- Are differential effects of auditory distraction observed in speakers with different primary characteristics of dysarthria?

HYPOTHESES
- Listener ratings of dysarthric speech will show greater declines in intelligibility with increased levels of auditory distraction than normal speech.
- As severity of dysarthria increases, the negative effects of auditory distraction upon speech intelligibility will increase.

METHOD
- **Listeners**: Fifty-six (56) undergraduate female listeners ranging in age from 18 to 45 years (M=22 years).
- **Procedure**: Listeners were asked to make perceptual judgements of intelligibility across four conditions of auditory distraction: no auditory distraction and distraction at +3 dB SNR, 0 dB SNR, and -3 dB SNR. Listeners completed the task in four groups of 14. Order of conditions was counterbalanced across groups.
- **Auditory distraction**: Multi-talker babble was employed for auditory distraction. For distraction conditions, babble began with the speech stimuli and continued during the rating process.
- **Speech stimuli**: Were derived from the first five sentences of the Grandfather passage. Recordings were obtained from three adult males with traumatic brain injury (TBI) and three age-matched controls (see Table 1). A total of eight samples were played at each condition – six speech samples and two repetitions for reliability purposes.

METHOD cont.
- **Intelligibility**: Rated by 10 students of speech pathology using direct magnitude estimation (free modulus paradigm). Intelligibility described as “the ease with which speech could be understood” [4].
- **Statistics**: A 2 x 4 mixed between-within subject ANOVA (p<0.05) was conducted to explore the effects of speaker and distraction. Post hoc pairwise comparisons were conducted using Holm-Sidak pairwise multiple comparisons with p values adjusted for multiple comparisons. Secondly, examination of individual TBI participant data was conducted using a series of three one-way repeated measures ANOVA with an alpha level of 0.05. Post hoc analysis was conducted using pairwise multiple comparison procedures (Tukey test) with adjusted alpha.

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>S1</td>
<td>58</td>
<td>39</td>
<td>Severe spastic-ataxic</td>
</tr>
<tr>
<td>S2</td>
<td>52</td>
<td>32</td>
<td>Moderate ataxic</td>
</tr>
<tr>
<td>S3</td>
<td>35</td>
<td>16</td>
<td>Moderate-severe spastic-ataxic</td>
</tr>
</tbody>
</table>

- **Reliability**: Mean intra-participant reliability was 0.85 (SD = 0.14). Inter-listener reliability was 0.98 (Cronbach’s alpha).

RESULTS
- Significant effects were observed for group (F=49.57, p<0.001) and condition (F=75.48, p<0.001) with the group X condition interaction also significant (F=20.74, p<0.001) (see Figure 1).
- Post-hoc testing indicated that perceived intelligibility of the dysarthric group was significantly reduced at each condition (p<0.005).

RESULTS cont.
- All post hoc pairwise tests were significant (p<0.001) for the control group indicating that intelligibility ratings decreased significantly with each condition of reducing SNR.
- The dysarthric group exhibited significantly reduced perceived intelligibility at both the 0 dB (p<0.05) and -3 dB (p<0.05) SNR conditions compared to the no noise condition only.
- All speakers exhibited significant changes to perceived speech intelligibility across conditions (p<0.001) (see Figure 2) with differential effects observed on post-hoc testing (see author for full results).

DISCUSSION
- The perceived intelligibility of dysarthric speech was not affected by background noise in the same way as normal speech.
- This may have been due to: (1) Listener effort, (2) Cognitively motivated selective attention; (3) Measurement effect.
- Differential effects were noted by speaker with the intelligibility ratings for speaker 3 more affected by decreasing SNRs than either speaker 1 or 2.
- These results suggest that the distinctive speech characteristics of dysarthria type may be uniquely influenced by the presence of noise.
- Future research should consider: (1) Modification of the dependent variable; (2) Use of word or phrase-level experimental stimuli; and (3) acoustic analysis of perceptual speech features.

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REFERENCES
3. Figure 1. Rate and intensity manipulation in dysarthria. Acoustics and perceptual Hearing. Journal of Speech, Language, and Hearing Research, 49(7), 2303-2311.
4. Table 1. Intelligibility ratings for individual dysarthric speakers across conditions.

Figure 1: Intelligibility ratings across group and condition.

Figure 2: Intelligibility ratings for individual dysarthric speakers across conditions.