Contemporary Issues in the Clinical Management of Dysarthria

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Important Matters

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- Thank you to Catholic Health SLPs for your role in helping UB develop the medical SLP pipeline
Agenda

- Classification of Dysarthria
- What’s new in treatment research
- Intelligibility and beyond
Methods for Dysarthria Classification

- Perceptual

  - Clinical gold standard

  - Based on research in late 1960s from Mayo Clinics in Rochester, MN
# Mayo System

(Darley et al., 1969 a&b; Duffy, 2013)

<table>
<thead>
<tr>
<th>Dysarthria Subtype</th>
<th>Etiology</th>
<th>Pathophysiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaccid</td>
<td>Bulbar palsy</td>
<td>Weakness</td>
</tr>
<tr>
<td>Spastic</td>
<td>Pseudobulbar Palsy</td>
<td>Spasticity</td>
</tr>
<tr>
<td>Ataxic</td>
<td>Cerebellar lesion</td>
<td>Incoordination</td>
</tr>
<tr>
<td>Hypokinetic</td>
<td>Parkinsonism</td>
<td>Rigidity</td>
</tr>
<tr>
<td>Hyperkinetic</td>
<td>Dystonia/Chorea</td>
<td>Involuntary Movements</td>
</tr>
<tr>
<td>Mixed</td>
<td>ALS</td>
<td>Weakness/Spasticity</td>
</tr>
<tr>
<td>Unilateral UMN</td>
<td>Stroke</td>
<td>Weakness/Incoordination/Spasticity</td>
</tr>
<tr>
<td>Undetermined</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>
Mayo System Implications

- Pathophysiology of neurological disease (i.e., weakness, spasticity, incoordination) explains deviant perceptual characteristics
  - Slow rate, imprecise consonants, monopitch, breathy voice, etc.

- Speech pathology reflects neuropathology and thus, auditory-perceptual judgments have localizing power
Challenges of Mayo System

- Poor reliability (even expert judges!) of fine-grained perceptual judgments (i.e., monopitch, short phrases)

- Lack of research supporting relationship between pathophysiology in speech mechanism and deviant perceptual characteristics

- Overlap among subtypes
Alternative Approaches Classification
(Tjaden, Lam & Feenaughty, in press)

• Instrumental measures of speech production (acoustics)

• Auditory-based Free Classification approach
Acoustic Classification (Kim, Kent & Weismer, 2010)

- N=107
  - Parkinson’s, MSA, Stroke, TBI
- Acoustic measures of articulation, voice pitch, vocal intensity, prosody
- Scaled Sentence Intelligibility
- Dysarthria diagnosis ala Mayo System made by J. Duffy
  - Ataxic, spastic, hypokinetic, flaccid, hyperkinetic, UUMN and mixed
Acoustic Classification \( (\text{Kim, Kent & Weismer, 2010}) \)

- Using acoustic measures, speakers were classified correctly by:
  - Mayo dysarthria diagnosis (32%)
  - Scaled sentence intelligibility (55%)
  - Medical etiology (68%)

  ***Mayo System dysarthria diagnosis may not provide additional insight to interpreting production deficits beyond info provided by intelligibility or etiology***
Summary and Implications

- Many acoustic similarities were found across Mayo subtypes of dysarthria
  - Slower than normal rate (except some hypokinetic)
  - Compressed vowel space area
  - Reduced rate of formant frequency change (i.e., shallower diphthong F2 Slope)
  - Reduced phonetic contrasts

- **Taxonomical approach** to classification may be feasible.
The standards committee met this afternoon in an open meeting.

Legend:
Screen shot of the PowerPoint slide used for the free-classification task in its beginning position. Each of the initialed black icons located on the left side of the slide was paired with a specific speaker's sound file. When the icons were double-clicked, the sound file would play.
• 6 clusters with multiple Mayo subtypes comprising a single cluster

• Perceptual-acoustic dimensions
  1) Voice Quality
  2) Rate
  3) Intelligibility
TREATMENT
State of Affairs

- Impartial comparative studies rare
- Single etiology (TBI, Parkinson’s)
- Outcomes focused on Body Functions & Structures (impairment)
Global Dysarthria Treatment Techniques

• Change in “gross” or “overall” speech parameters such as prosody, rate, loudness and clarity

• Elicit simultaneous change in multiple speech components

• Applied at the level of the utterance
  • Benefits listener’s ability to use perceptual strategies to parse the acoustic speech stream into words
Research at UB Motor Speech Disorders Lab

• **Speakers**
  - Multiple Sclerosis (MS)
  - Parkinson’s disease (PD)
  - Healthy age and sex-matched controls

• **Global Treatment Techniques**
  - Rate manipulation (slow rate)
  - Increased vocal intensity (increase loudness)
  - Clear speech style (slow rate+increase loudness)

• **Outcomes**
  - Speech production (Impairment)
  - Perceived speech adequacy (Activity Limitations)
# Global Techniques: Impact on Production

(Tjaden et al., 2013 a&b)

<table>
<thead>
<tr>
<th></th>
<th>Clear</th>
<th>Loud</th>
<th>Slow</th>
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<tbody>
<tr>
<td>Articulation Rate</td>
<td>-</td>
<td>=</td>
<td>-</td>
</tr>
<tr>
<td>Segment Durations</td>
<td>-</td>
<td>=</td>
<td>-</td>
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<tr>
<td>Mean Sound Pressure Level</td>
<td>+</td>
<td>+</td>
<td>=</td>
</tr>
<tr>
<td>F0 Range</td>
<td>+</td>
<td>+</td>
<td>-</td>
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<tr>
<td>Tense and Lax Vowel Space Areas</td>
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<td>+</td>
<td>+</td>
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<tr>
<td>Dynamic Vowel Spectral Change for Tense and Lax Vowels</td>
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<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Tense-Lax Vowel Spectral and Temporal Distinctiveness</td>
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<td>=</td>
<td>=</td>
</tr>
<tr>
<td>Diphthong F2 Slope</td>
<td>+</td>
<td>=</td>
<td>-</td>
</tr>
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</table>

- Prosody and rate
- Articulation
Global Techniques: Impact on Intelligibility

(Tjaden et al., 2014 a&b)

- Clear and Loud similarly improved intelligibility by ~10%
- Slow did not enhance intelligibility
Clear Speech: Impact of Cueing
(Lam & Tjaden, 2012; 2013)

- All clear speech cues increased intelligibility
  - Cue to “overenunciate” maximized intelligibility
    - 11% better, on average, than “speak clearly”
INTELLIGIBILITY AND BEYOND
The Issues

• Sensitivity to mild dysarthria
  • Intelligibility in adverse perceptual environments

• Objective versus subjective metrics
Published Clinical Metrics of Intelligibility
(Sussman & Tjaden, 2012)

Single Word Intelligibility

Sentence Intelligibility
Speech Severity

• Continuous visual analog scale (150 mm line)

“Rate overall severity, paying attention to
1) Voice
2) Resonance
3) Articulatory precision
4) Speech rhythm

“Pay attention to overall speech naturalness and prosody. Do not focus on intelligibility or the understandability of speech”

Severely Impaired (1.0)

Not impaired (0)
Speech Severity

Expert Judges

Inexperienced Judges

Scaled Severity (% Impaired)

<table>
<thead>
<tr>
<th></th>
<th>CSF</th>
<th>CSM</th>
<th>MSF</th>
<th>MSM</th>
<th>PDF</th>
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<tr>
<td><strong>Expert Judges</strong></td>
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<tr>
<td><strong>Inexperienced Judges</strong></td>
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Types of Intelligibility Metrics

Objectives: Transcription
- Quantitative gold standard
- Index of dysarthria severity
- Time consuming to administer and score

Subjective: Scaling Tasks
- Index of dysarthria severity
- Efficient to administer/score
- Can be easily applied to longer connected speech tasks
- Impressionistic
- Listener reliability concerns
Sentence Intelligibility Metrics

Transcription Intelligibility

Scaled Intelligibility: Visual Analog Scale
Intelligibility and Beyond Summary

• Visual Analog Scaling of Speech Severity may be useful for mild dysarthria
  • Strongly preferred to interval scales (0, 1, 2, 3, 4, 5 etc.)

• Multi-talker babble mimics ecologically-valid perceptual environments
  • May be more indicative of ICF Participation

• Visual analog scaling results comparable to traditional orthographic transcription
THANK YOU