New Insights into the Treatment of Dysarthria

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Leslie Mahler, PhD, CCC-SLP
Associate Professor, Dept of Communicative Disorders,
University of Rhode Island
Why are we here to talk about new insights into treatment of dysarthria?
Occurrence of Dysarthria

• **Acute care** – 80% of patients
• **Outpatient** – 50%
• **Adults and children**
Causes

- **Stroke** – 5 million in the US; 20-40% have a type of dysarthria
- **Traumatic brain injury** - 33%
- **Parkinson disease** – 60-89%
- **ALS** – 100%
- **Down syndrome**
- **Cerebral palsy**
Negative Impact of Dysarthria

- Decreased understandability
- Decreased naturalness
- Negative attitudes or discrimination
- Diminished engagement in communication


Presentation Format

- Define dysarthria & implications
- There is not one right way to treat dysarthria
- Principles of neural plasticity
- Encourage you to do clinical research
- Questions
Dysarthria Defined

• *Dysarthria is a speech disorder resulting from a weakness, paralysis, or incoordination of the speech musculature that is of neurological etiology.*

• *Darley, Aronson, & Brown, 1969*
Updated definition, Duffy

- A collective name for a group of neurologic speech disorders resulting from abnormalities in the strength, speech, range, steadiness, tone or accuracy of movement required for control of speech systems. (p. 5)
Implications of the Definition

• It is neurologic in origin
• There are distinct types of dysarthria
• The effects of neuropathology on speech are clinically unique and recognizable; dysarthria types are associated with damage to specific areas of the central or peripheral nervous system
Dysarthrias are Heterogeneous

- Flaccid
- Spastic
- Unilateral upper motor neuron
- Ataxic
- Hypokinetic
- Hyperkinetic
Flaccid Dysarthrias

- Produced by injury to one or more of the cranial or spinal nerves (final common pathway)
- Main characteristics are weakness and reduced muscle tone
- Diminished reflexes
Spastic Dysarthria

What is it?
- Produced by **bilateral** damage to the direct and indirect activation pathways of the CNS.
- Combined effects of weakness and spasticity in a manner that slows movement and reduces its range and force of movement
Ataxic Dysarthria

• Associated with damage to the cerebellar control circuit
• It is characterized by changes in articulation and prosody
• Incoordination, decreased accuracy and poor timing
Basal Ganglia Control Circuit

- Regulates tone and facilitates automaticity of movements for skilled automatic acts
- Participates in organization of movements
- Integrates complex movement patterns
Hypokinetic Dysarthria

- Involves an imbalance between dopamine and acetylcholine, causing:
  - Tremor
  - Rigidity
  - Hypokinesia
  - Bradykinesia
  - Too little movement
  - Parkinson disease
Hyperkinetic Dysarthrias

- Also associated with diseases of the basal ganglia control circuit.
- Excessive movement
- Rhythmic or irregular and unpredictable rapid or slow involuntary movement
- Too much unwanted, involuntary movement as in Huntington’s disease
UUMN Dysarthria

- Results from damage to the upper motor neuron pathways
- Named for its anatomy rather than pathophysiology since characteristics are variable
- It is most apparent when it involves articulation, phonation, and/or prosody
Lack of Evidence

• What treatment approaches work for specific types of dysarthria?
• It is not surprising that there is a lack of treatment efficacy studies given the heterogeneity of dysarthria types and causes.
Exercise based treatments can work

- Basic science evidence for the value of exercise
- Identified key principles of exercise that drive activity-dependent neural plasticity
- Demonstrated that exercise can improve brain functioning (neural plasticity)
- Exercise is Medicine!

JSHLR Kleim & Jones, 2008; Kleim et al, 2003; Maas et al., 2009; Zigmond et al, 2009
Principles of Motor Learning

- Intensity of practice
- Blocked vs. variable practice
- Use or lose it
- Use it and improve it
- Skill specificity
- Saliency
- Augmented feedback
Intensity of Practice

• A large number of practice trials provide more opportunities to improve motor programs for control of speech production subsystems

(Bhogal, Teasell & Speechley, 2003; Maas et al., 2008)
Blocked vs. Variable Practice

• In general, short periods of intense variable practice will result in learning more than longer blocked practice sessions.
Use or Lose It

• Lack of use of motor programs can lead to degradation of the representation of the motor movement in the nervous system
Use it and Improve It

• Consistent use of specific skills can increase neural control of the motor skill practiced.

(Kleim & Jones, 2008; Ludlow et, 2008)
Skill Specificity

• The complexity of the motor skill practiced should be specific to the motor skill to be learned.

• If the goal of treatment is improved speech intelligibility then the majority of treatment tasks should include real speech with varying levels of cognitive-linguistic complexity.
Saliency

• A patient’s motivation for learning a new motor skill is extremely important.

• Selecting treatment materials that are relevant to the individual are extremely important for carryover and generalization outside the treatment room.
Mechanisms of activity-dependent Neuroplasticity

- Neurotrophic factor expression
- Neurogenesis
- Synaptogenensis
- Synaptic modulation
- Glucose utilization
- Reduce inflammation

(Cotman & Berchtold, 2002; Kleim JA, Jones TA, & Schallert T. (2003))
How do we translate this research to our clinical practice in speech-language pathology?

Start with Parkinson disease
Nearly 90% of over 6 million individuals with PD worldwide have a speech problem.

Classic Speech & Voice Symptoms in IPD?

- Reduced loudness, monoloudness
- Monotone
- Hoarse voice quality

Mahler, Ramig & Fox, 2015
Integrating Motor Learning Principles in Treatment

**Intensity matters**
Intensive dosage is important for maximal plasticity and generalization

**Intensity includes multiple repetitions in a session**
Induction of plasticity requires sufficient repetition (Kliem et al., 2004)

**Saliency matters**
Practicing rewarding tasks (success/emotionally salient) activates basal ganglia circuitry.

**Use it and improve it**
-Train the deficits to improve function.

(Alexander et al., 1990; Fox et al., 2002; Graybiel 1998; Kliem et al., 2003; Kleim and Jones, 2005; Jones et al. 1999; Saint-Cyr JA, 2003; Tillerson et al., 2002; Vergara-Aragon et al., 2003; Black et al. 1990; Comery 1995; Fisher et al., 2004; Kleim et al., 2001; 1996; Perez et al. 2004; Pisani et al., 2005; Plautz et al., 2000)
Treatment of Dysarthria Secondary to Stroke

Why stroke?
(Select your population carefully)

• Stroke is the leading cause of disability in the US (AHA, 2003; Page, Gater, & Bach-y-Rita) and dysarthria can interfere with communication following a stroke
  – (54% of acquired communication disorders, Duffy, 2005; Walshe, 2010)

• Negative impact of dysarthria on functional communication (Dickinson et al., 2008)
How would you begin a treatment study?

• **Start with what is known**
  – *Established treatment with new population*
  – *Well understood population with a new treatment*

• **Standardize;**
  – *Evaluation procedures – key dependent variables; what matters most?*
  – *Treatment*
  – *Eliminate potential bias*
Research Design

- Multiple single subject A-B-A
- Statistics
  - Paired sample t-test or ANOVA
  - Effect size
  - Change greater than 1 standard deviation
Participants

• All participants had chronic stroke; Three were 2+ years post onset and one was 9 months post onset
  – All had a left sided cortical lesion;
  – 3 men and 1 woman
  – Ages 50-75
  – Variety of dysarthria types

• All had received prior speech treatment but not for dysarthria
Evaluation Tasks

• Variety of speech tasks
  – WAB picture description
  – Sentence reading
  – Paragraph reading
  – Task description
  – Single word list

• Sustained “ah”
Dependent Variables

• dB SPL during speech tasks and Ah
• % single word intelligibility
• Vowel triangle area
• MDVP measures of relative average perturbation (RAP) and percent perturbation quotient (PPQ)
• Listener perceptual ratings of speech comparing pre-post treatment
Treatment of Dysarthria Secondary to Cerebral Palsy (CP)

Mahler (in preparation)
Cerebral Palsy

- Dysarthria is common in people with CP and is typically characterized by:
  - Hypernasality
  - Breathy voice quality
  - Reduced loudness
  - Rate abnormalities

Results

• Single word intelligibility increased from 58% pre-treatment to 86% post-treatment

• Statistically significant improvements in loudness during less cognitively demanding speech tasks and sustained “Ah”
<table>
<thead>
<tr>
<th>Task dB SPL</th>
<th>Pre-Treatment Average (SD)</th>
<th>Post-Treatment Average (SD)</th>
<th>Difference</th>
<th>Paired sample t-test</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sentence Reading</td>
<td>68.00 (1.05)</td>
<td>72.80 (0.47)</td>
<td>4.80</td>
<td>0.01</td>
<td>0.95</td>
</tr>
<tr>
<td>Picture Description</td>
<td>70.50 (1.44)</td>
<td>72.58 (0.42)</td>
<td>2.08</td>
<td>0.13</td>
<td>0.70</td>
</tr>
<tr>
<td>Task Description</td>
<td>68.97 (1.55)</td>
<td>71.50 (0.75)</td>
<td>3.53</td>
<td>0.20</td>
<td>0.72</td>
</tr>
<tr>
<td>Sustained “Ah”</td>
<td>66.63 (1.55)</td>
<td>86.93 (0.36)</td>
<td>18.30</td>
<td>0.00</td>
<td>0.99</td>
</tr>
</tbody>
</table>
Treatment of Dysarthria Secondary to Scleroderma

Systemic Scleroderma

• A connective tissue disease involving the skin, blood vessels, skeletal muscles, and internal organs (Pizzo et al., 2003)

• Orofacial and laryngeal changes have been identified that may interfere with speech and swallowing

• No known speech treatments described in the literature to date
Results

• Single word intelligibility increased from 86% pre-treatment to 91% post-treatment

• Statistically significant improvement in loudness across all speech tasks and sustained “Ah”
<table>
<thead>
<tr>
<th>Task dB SPL</th>
<th>Pre-Treatment Average (SD)</th>
<th>Post-Treatment Average (SD)</th>
<th>Difference</th>
<th>Paired sample t-test</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sentence Reading</td>
<td>71.13 (0.45)</td>
<td>78.98 (1.50)</td>
<td>7.84</td>
<td>0.004</td>
<td>0.96</td>
</tr>
<tr>
<td>Picture Description</td>
<td>69.10 (0.26)</td>
<td>77.73 (1.33)</td>
<td>8.63</td>
<td>0.001</td>
<td>0.96</td>
</tr>
<tr>
<td>Task Description</td>
<td>68.97 (0.38)</td>
<td>76.13 (0.72)</td>
<td>7.16</td>
<td>0.001</td>
<td>0.97</td>
</tr>
<tr>
<td>Sustained “Ah”</td>
<td>70.0 (0.25)</td>
<td>85.5 (0.36)</td>
<td>15.47</td>
<td>0.000</td>
<td>0.99</td>
</tr>
</tbody>
</table>
Treatment of Dysarthria Secondary to Down Syndrome (DS)

Why Down Syndrome?

- Communication disorders occur commonly in DS frequently including dysarthria
- Therapy typically focuses on cognitive-linguistic deficits
- Speech treatments in DS have received little attention even though speech deficits may have a negative impact on quality of life and social participation (Stoel-Gammon, 2001)
Aim of the Study

- Determine the impact of two distinct treatments administered consecutively to two adults with DS and dysarthria
  - Treatment 1: Voice
  - Treatment 2: Articulation
Participant characteristics

DS01: 33-y/o female. Speech signs included:
• Reduced loudness
• Reduced stress
• Aberrant use of pitch
• Hypernasality
• Hoarse voice
• Dx: Severe flaccid dysarthria

DS02: 32-y/o male. Speech signs included:
• Reduced loudness
• Aberrant prosody
• Pitch breaks
• Harsh voice
• Dx: Moderate flaccid dysarthria
Experimental Overview

- A-B-A-C-A single-subject experimental design
- Four measurements of dependent variables over one-week during each A phase
- Dependent variables included:
  - $dB\text{ SPL}$ (vowel prolongation, sentence & paragraph reading, picture & task description)
  - Single word intelligibility
  - Lip & lingual effort in kPa (articulation only)
Results

### Single Word Intelligibility; 50 phonetically balanced words

*(Bunton, Leddy & Miller 2007)*

Three Unfamiliar Listeners

<table>
<thead>
<tr>
<th></th>
<th>Pre-Voice %</th>
<th>Post-Voice %</th>
<th>Pre-Post Mean Difference</th>
<th>Paired Sample t-test</th>
<th>Effect Size r</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DS01</strong></td>
<td>62.67 (4.16)</td>
<td>67.33 (5.03)</td>
<td>4.66%</td>
<td>0.47</td>
<td>0.45</td>
</tr>
<tr>
<td><strong>DS02</strong></td>
<td>73.33 (3.06)</td>
<td>91.33 (1.15)</td>
<td>18.0%</td>
<td>0.02</td>
<td>0.96</td>
</tr>
</tbody>
</table>
Articulation Treatment for Dysarthria secondary to Down Syndrome
Articulation Treatment

- Four weeks of 16 individual one-hour sessions focused on speaking clearly
- IOPI exercises with lips and tongue
- Sustained vowel phonation
- Counting to 15
- Minimal pairs based on individual sound errors identified pre-treatment
- Salient sentences & structured dialogue
- Homework and carryover tasks
## Lip and Lingual Pressures

<table>
<thead>
<tr>
<th></th>
<th>Average kPa Pre (SD)</th>
<th>Average kPa Post (SD)</th>
<th>Pre-Post Mean Difference</th>
<th>t-test</th>
<th>Effect Size r</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lips</td>
<td>12.83 (1.50)</td>
<td>19.43 (1.26)</td>
<td>6.6 kPa</td>
<td>0.00</td>
<td>0.92</td>
</tr>
<tr>
<td>Tongue</td>
<td>21.75 (3.10)</td>
<td>49.00 (4.53)</td>
<td>27.3 kPa</td>
<td>0.00</td>
<td>0.96</td>
</tr>
<tr>
<td>DS02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lips</td>
<td>34.75 (3.46)</td>
<td>45.43 (1.18)</td>
<td>10.7 kPa</td>
<td>0.01</td>
<td>0.90</td>
</tr>
<tr>
<td>Tongue</td>
<td>39.33 (1.37)</td>
<td>44.00 (0.96)</td>
<td>4.67 kPa</td>
<td>0.00</td>
<td>0.66</td>
</tr>
</tbody>
</table>
# Single Word Intelligibility

## Three Unfamiliar Listeners

<table>
<thead>
<tr>
<th></th>
<th>Pre-Voice %</th>
<th>Post-Voice %</th>
<th>Post-Artic %</th>
<th>Post-Voice to Post-Artic Mean Difference</th>
<th>t-test</th>
<th>Effect Size r</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS01</td>
<td>62.67 (4.16)</td>
<td>67.33 (5.03)</td>
<td>80.00 (2.00)</td>
<td>12.70%</td>
<td>0.01</td>
<td>0.86</td>
</tr>
<tr>
<td>DS02</td>
<td>73.33 (3.06)</td>
<td>91.33 (1.15)</td>
<td>96.00 (2.00)</td>
<td>64.67%</td>
<td>0.10</td>
<td>0.82</td>
</tr>
</tbody>
</table>
Summary

- Decreased intelligibility plays a significant role for people with dysarthria;
- Negatively impacts social participation
- Limits the potential to benefit from cognitive/linguistic treatment
- So it is important research to undertake
Discussion

- Even people in the chronic stages of recovery can improve
- More research is needed
- Consider doing treatment as part of your clinical practice
- Integrate principles of motor learning into treatment to drive activity dependent changes in neural plasticity
Discussion

- Measuring the impact of treatment on communication is difficult
- Non-responders:
  - CP
  - Stroke
  - Down syndrome
  - Parkinson disease
Thank you!

- Leslie Mahler
  - lmahler@uri.ed
  - 401-874-2490