Why are we interested in intelligibility?

• Because the functional purpose of speech communication is to be understood, intelligibility is the functional common denominator of verbal behavior

• Effectiveness of communication

Intelligibility Definition
Research/Acoustics focus:

Based on...
Perceptual judgments of human listeners who:

Use their auditory nervous system and knowledge of the language to make judgments about the extent to which they understand utterances produced by a talker

(M. Hodge, 2004)

Intelligibility Definition
Clinical focus

• Accuracy with which a message is conveyed (Yorkston & Beukelman, 1980)

• Degree to which the speaker’s intended message is recovered by the listener (Kent et al., 1989)

Intelligibility Definition
Research/Acoustics focus

• Refers to the extent to which an acoustic signal, generated by a speaker, can be recovered by a listener
Our focus

• Speaker
  – Subsystems
    • Respiratory
    • Phonatory
    • Articulatory
    • Velopharyngeal
  – Range of impairment (mild to profound)

Consequences of impaired intelligibility

• Reduced ability to participate in life activities
• Inability to communicate wants and needs

Impact of disease/disorder

World Health Organization International Classification of Functioning, Disability, and Health (2002)

• 1. person’s body structures (anatomy) and functions (physiology)
• 2. person’s ability to engage in activities
• 3. person’s ability to participate in his or her life

Comprehensibility

• “the degree to which the listener understands the utterance in a communicative context”
Working definitions:

• Intelligibility refers to an acoustic signal produced by a speaker and understood by a listener.

• Comprehensibility encompasses a broader range of contextual factors which may affect understanding, including syntax, semantics, and environmental factors.

Which term to use?

• Intelligibility
  — Assessed by words transcribed, not related to actual meaning or understanding

• Comprehensibility
  — Assessed by listener comprehension
    • Ability to answer questions about message
    • Ability to summarize content

Intelligibility Assessment:

Assessment = research study of one client’s intelligibility.

How do we generally assess intelligibility?

• Informal (reporting)

• Formal (standardized measures)

Reporting speech intelligibility:

• Joe’s speech is 60% intelligible.
  — Conditions are important
    • Material
    • Personnel
    • Training
    • Test procedure

• Joe’s speech is 60% intelligible on single-words as judged by a familiar listener with an audio taped sample with shared context.

Published Tests (Intelligibility)

• AIDS, CAIDS, SIT (Yorkston & Beukelman, 1981, 1995)

• Frenchay Dysarthria Assessment (Enderby, 1983)

• Phonetic Intelligibility Testing (sound inventory) Kent, et al. (1989)

Assessment of Intelligibility of Dysarthric Speech (AIDS/CAIDS/SIT)

• Sentence transcription

• Single word transcription

• Single word multiple choice

• Listener transcribes sample, percentage of words is then determined ( # of correct words divided by total # of words)
### Intelligibility Measures

- Snapshot of speech
- Taken at any given moment in time
- One particular set of stimuli
- One particular listener

### Intelligibility

- Critical to development of treatment plans
- Involves speaker, medium, listener
- Dyadic – efforts of both speaker and listener

### Factors that may influence intelligibility:

- Speaker characteristics
- Listener characteristics
- Stimuli characteristics
- Methodological characteristics
  - Transcription type
  - Visual information

### Speaker characteristics that influence intelligibility

- Severity of intelligibility impairment
- Dysarthria type (related to type of neurological impairment)
- Individual factors related to speaker

### Intelligibility Severity of Speaker

- Consider how it is being measured
  - Intelligibility transcription measure
  - Subjective clinician rating

### Influence of Severity

- Huge range of severity in speakers with impaired intelligibility
- Many studies are now finding an interaction between variables and severity.
- In some cases, more severe speakers have more room to benefit from strategies
- In others, there is not much to work with, so results can be variable
Influence of Dysarthria Type

- Speakers with different etiologies will look and sound different from each other.
- Progressive, recovering, remission
- More of a research than a clinical problem but read research with a critical eye if many dysarthria types are included in the same study.

Individual Factors

- Medication cycle
- Fatigue
- Motivation
- Family/caregiver support

Listener characteristics that influence intelligibility

- Experience with disordered speakers
- Familiarity with the speaker
- Familiarity with the stimuli

Listener experience with disordered speakers

- Clinicians experienced with disordered speakers obtained higher transcription scores than inexperienced listeners (Yorkston & Beukelman, 1980) & Barkmeier (1988)
- Our measurement tools do not specify who listeners should be.
- Utilize listeners effectively.

Listener familiarity with the speaker

- Some conflicting results
  - Prior familiarization with a specific speaker led to increased intelligibility scores (Mustad & Cahill, 2003, Spitser et al, 2000, Tjaden & Liss, 1995)
  - No difference when listener was familiarized (Garcia & Cannito, 1996, Yorkston & Beukelman, 1983)
- May affect scores and should be considered in selection of listeners.

Listener familiarity with the stimuli

- Listeners familiar with the stimuli produced higher scores than those not familiar (Yorkston & Beukelman, 1980)
- Use unfamiliar stimuli to ensure a more functional measure of intelligibility
Influence of Speech Stimuli Characteristics

- Semantic Predictability
- Semantic Cohesion
- Length of Utterance

Semantic Predictability

- Research Factors
  - High versus Low Predictability SPIN sentences
    (Kalikow, Stevens, Elliot, 1977)
  - She is drinking from her _____.

Bob would consider the _____.

- Clinical Considerations
  - High predictability will allow listeners
    more information

Semantic Cohesion

- Research Factors
  - Key words/Cohesion = higher scores
    (Drager & Reichle, 2001 and Hustad & Beukelman, 2002)

- Clinical Considerations
  - Keep ideas related for listener benefit
  - This works in our favor in natural communication

Length of utterance

- Research Factors
  - Word is harder to understand in isolation than in a sentence

- Clinical Considerations
  - Provide context whenever possible
    - Teach your speakers to present it
    - Instruct your listeners to look for it

Methodological characteristics that influence intelligibility

- Transcription task
- Presentation mode

Influence of transcription task

- Open-ended vs Multiple choice
- Single words vs sentences
- Sentences vs longer utterances
Influence of presentation mode on intelligibility

- Most of our standardized measures rely on auditory-only information.
  - AO (auditory only)
    - vs
  - AV (auditory-visual)

Summary of Visual Information Intelligibility Studies

<table>
<thead>
<tr>
<th>Normal</th>
<th>AV &gt; AO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing Impaired</td>
<td>AV &gt; AO</td>
</tr>
<tr>
<td>Laryngectomee</td>
<td>AV &gt; AO</td>
</tr>
<tr>
<td>Dysarthria</td>
<td>Mixed</td>
</tr>
</tbody>
</table>


Visual Information in Dysarthria

- AV > AO in 3/8 speakers w/ PD (Keirtz, et al, 2007)
- AV > AO in 1/5 speakers w/ CP (Hustad & Cahill, 2003)
- AV > AO in mod speakers w/ CP
  AV = AO in severe speaker w/ CP (Hunter, et al 1990)
- AV > AO in 12/12 speakers w/ various etiologies (Barkmeier, 1988)

Visual Information

- Why do we care about visual information?
- Buy Bobby a puppy.
- Here is his hand.
- Consider whether some speakers will benefit if seen or not.

Visual Information

- Bilateral facial paralysis
  - Duffy orofacial example

Visual Information

- Moebius Syndrome
  - Research (statistical) benefit
  - vs Clinical benefit
### Measuring Communicative Effectiveness

Part of ongoing evaluation and will be helpful in shaping a functional treatment program specific to each client's needs.

Rating Scales can be useful.

### Options for Measurement

- **Communication Effectiveness Survey**
  - Converse/family/quiet
  - Phone/family
  - Converse/stranger/quiet
  - Converse/riding in car
  - Phone/stranger
  - Upset
  - Across room
  - Converse/noisy setting

### Options for Measurement

- **Communication Effectiveness Survey**
  - Unable to assume progress in one domain will carry over (need to assess each separately).
  - CES – preliminary validity and reliability but is being upgraded/improved


### Options for Measurement

- **Dysarthria Impact Profile**
  - 5 domains
    - Effects of dysarthria on me as a person
    - Accepting of my dysarthria
    - How I feel others react to my speech
    - How dysarthria affects my communication with others
    - Dysarthria relative to other worries and concerns

### Options for Measurement

- **Evaluating Social Networks**
  - Person with dysarthria charts social networks before and after onset
    - Life partners
    - Good friends
    - Acquaintances
    - Paid professions
    - Unfamiliar people

- **Dysarthria Impact Profile**
  - As of November, 2010 was under revision
  - Further revisions and validation is being conducted.

  Walsche, Peach, & Miller (2009)
Options for Measurement

- Evaluating Social Networks
- Found to be a useful tool to document change in communication interaction
- More suited to people with severe dysarthria using AAC systems.

Intervention Paths

1. Remediation of underlying impairments in the speech subsystems
2. Reduction of activity limitations and participation restrictions that are imposed by the dysarthria

[Hustad & Weismer, 2007]

Management of Intelligibility Impairment

- Critical to consider the impact of the person’s etiology on the treatment you select.
- Improving
- Degenerating
- Chronic/stable
- Remitting

Ultimate goal = improved communication

- 2 key problems may hinder this
  - 1. failure to address CURRENT communication needs
  - 2. failure to address FUTURE needs or problems

Yorkston & Beukelman (2000)


1. No detectable communication disorder
2. Obvious disorder with intelligible speech, writing, and functional reading
3. Reduced intelligibility
4. Residual speech supplemented by augmentative techniques
5. No functional speech

Interventions to remediate the underlying impairment

- Speech mechanism exercises
- Pharmacologic and surgical intervention
- Subsystem specific intervention
### Speech mechanism exercises

- Dysarthria often = weakness, reduced control
- Also,
  - difficulty holding steady contractions
  - difficulty with rapid and accurate movements
  - difficulty with strength (due to fatigue)

### Speech mechanism exercises

- Defined here as a focus on variables such as
  - Strength
  - Speed of movement or contraction
  - Accuracy of movement
  - Coordination

Not involving actual speech production
- Theory – improvement in nonspeech will lead to improved speech

### Speech mechanism exercises

- Research has not yet established a meaningful relationship between nonspeech and speech production performance (Weismer, 2006; Lof, 2006).
- If the decision is made to incorporate these exercises, consider incorporating them as motor learning tasks or practices outside of the therapy session.
  - McNeill, Robin, & Schmidt, 1997

### Neuropharmacological and Neurosurgical Approaches

- Many medications and surgical procedures are options for patients who are experiencing neuromotor disorders.
  - (ex. Deep brain stimulation for PD)
- Usually, these intervention are focused on limb and other body functions (gait)
- May/may not have the same effects on speech/swallowing

### Respiratory System

- Common consequences of impairment
  - Short phrases
  - Low vocal intensity
  - Inability to produce phonation

- Treatment direction
  - Modification of tracheal pressures
  - Modification of inappropriate coordination
  - Modification of breath group size/content

- Yorkston, Spencer, & Duffy (2003a, 2003b)
Modification of Tracheal Pressure and Inappropriate Lung Volume

- Most likely way to increase loudness is to modify lung volume (have more air available)
- Many speakers with dysarthria initiate speech at low lung volumes
- Teach client to begin at a higher lung volume
- Teach clients NOT to exhale prior to beginning the utterance
- Sustained vowels – actual speech

Modifications of Coordination Between Components of the Chest Wall

- Be on the lookout for “paradoxical breathing” - one part of chest wall moves in an inspiratory direction and other part moves in an expiratory direction
- Common in some types of dysarthria
- Measure with a Respitrace
- May be resolved with abdominal binding (need MD order, see Hixon & Hoit, 2005)

Modification of Breath Group Size/Content

- Breath group = # of syllables or words produced in one breath
- Evaluated by counting, listening for speech naturalness
- May teach clients to use more appropriate boundaries (more/less frequent pauses)
  - Chunking

Modification of Breath Group Size/Content

- Breath pauses occurring at locations unrelated to syntax makes speech less intelligible
- Teach speakers to take pauses in natural breaks . . . Reading is a good way to practice

Phonatory System

- Common consequences of impairment
  - Low vocal intensity
  - Inability to produce phonation
- Treatment Direction
  - Respiration intervention often has an effect on phonation and vice versa
  - Common phonatory intervention = LSVT

Lee Silverman Voice Treatment (LSVT)

- Primary focus = phonation but research has shown carryover to other subsystem improvement
- “think loud” “think big”
- Goals
  - Increase respiratory support
  - Increase adduction
  - Increase phonatory effort
- Workshops required for certification
Phonatory System

- Source filter theory
  - Larynx produces source which gets filtered by articulators and their movements

- Does voice affect intelligibility?
  - Disordered source impacts final result
  - Garbage in/garbage out
- Include laryngeal function in intelligibility treatment

Velopharyngeal System

- Common consequences of impairment
  - Hypernasality
  - Reduced loudness
  - Affect intelligibility, also social impact

- Treatment Direction
  - Research has shown that exercises do not work
  - Palatal lifts (prostodontist fitted)

Articulatory System

- Common consequences of impairment
  - Lack of intelligibility due to misarticulation (mainly distortions)

- Treatment Direction
  - Direct approaches
    - Discuss placement, manual placement, practice of sounds
  - Indirect approaches
    - Slow rate, overarticulation, stressing sounds/syllables

Interventions to Reduce Activity Limitations and Participation Restrictions

- Prosody
- Speaking Rate
- Clear Speech
- Speech Supplementation Strategies
  - Iconic hand gestures
  - Topic supplementation
  - Alphabet supplementation
  - Combined topic/alphabet supplementation
- AAC technology, as necessary

Prosody

- Prosody – changes in intonation, stress, and rhythm of speech that are overlaid on speech sounds (Lehiste, 1970)
- Monopitch – common in dysarthria
- Feedback is important (biofeedback or listener)
- Exaggerated prosodic contours

- Pitch: level, variation
- Loudness: level, variation
- Rate: reading and spontaneous speech
- Phrasing: at syntactically appropriate junctures, length of breath groups
- Stress: cues used, aligned with appropriate words
Prosody Tasks

- Words with varying stress patterns
  - Noun-verb distinctions
    - CONduct vs conDUCT
  - Sentences with contrastive prosody
    - My blue car? vs my blue car.
    - That MAN ran fast vs That man RAN fast
    - Chocolate cookies and milk vs chocolate, cookies, and milk

Suggestions for addressing prosody

- Get Functional
  - Embed prosody into early stimuli/tasks
  - Choose functional stimuli
  - Choose meaningful, communicative contexts as tasks

Suggestions for addressing prosody

- Exploit residual abilities
  - Shape what they can control.
    - If a speaker can vary duration, help them exploit that to convey contrasts
  - Optimize success via any and all modalities
    - Facial expressions convey prosody (Massaro, 2008)
    - Gestures can convey prosody

Speaking Rate

- Clinical Issues –
  - Voluntary rate reduction tends to sound most natural
  - Knowing how speakers with dysarthria adjust speech and pause time could allow you to select techniques that capitalize on their strengths
    - Fewer syllables per breath group
    - Longer pauses
    - More frequent pauses

Clear Speech/Overarticulation

  - Speaker operates on a hypo-hyper continuum

  Casual
  “Th p’tatuh stew 2/vn th’ pah”
  (Economize effort)

  Canonical
  “The potato stew is in the pot”
  (Maximize Effort)
Clear Speech/Overarticulation

- Trade off between effort and segmental/suprasegmental accuracy
  - Greater than habitual effort = more canonical segmental and laryngeal phonatory output
- Trade off between rate and segmental accuracy
  - Slower than habitual rate = more canonical segmental acoustic output
  - Tjaden, K (ASHA, 2010)

Clear Speech/Overarticulation

- Predictions
  - Therapy techniques for dysarthria that elicit increased effort + reduced rate are predicted to most benefit articulatory and prosody deficits of dysarthria.

Clear Speech/Overarticulation

- Deliberate manner of speaking
  - Exaggerated articulation
  - Reduced rate
  - Increased loudness
- Most speakers tend to do this as a means of verbal repair

Iconic Hand Gestures

- Natural hand movement that add meaning to content words of the spoken message
- Research supports the use of this strategy
  - Garcia & Cannito, 1996
- Speakers who produce better gestures are likely to benefit more
- Research shows that use may actually have positive effects on speech production

Topic Supplementation

- Combines use of natural speech with a communication book, board, or device
- “It was hot and sunny today” might be preceded by the speaker pointing to the topic cue “weather”
- Research suggests modest improvements, depending upon severity of intell impairment

Alphabet Supplementation

- Combines natural speech with alphabet cues representing the first letter of each word of spoken messages.
- Sample board is included in handouts
- Research shows consistent improvement in intelligibility, more improvement in more severe speakers
- Also reduces rate
Combined Topic and Alphabet Supplementation

- 1st indicate topic, then use alphabet board
- Listener receives broad and specific info
- Few studies so far, but results are promising
- ? Remains if it is worth the effort to use both, rather than one or the other

AAC – for individuals who need extensive support

- Range from simple to complicated
- Consider stable, degenerating, improving
- Beukelman & Mirenda (2005)
- Beukelman, Yorkston, & Reichle, (1999)

Summary

- Improving speech intelligibility is often a primary treatment goal for individuals with dysarthria.
- Speech itself should be used to improve speech
- Functional communication should always be a focus (consider speaker and listener strategies)

Cases

- Stay tuned to our journals for the expanding research on improving intelligibility

THANK YOU

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Figure 9-3. A sample alphabet board for use with alphabet supplementation.

- I will point to the first letter of each word that I'm saying.
- Please repeat each word after I say it so I know you understood me.

Clinical Intervention Flowchart

Intelligibility Assessment & Speech Subsystems Assessment

- No detectable speech disorder
  - If course is degenerative, educate patient about potential problems

- Obvious speech disorder with intelligible speech
  - Improve naturalness, reduce underlying subsystem impairment

- Mild reductions in intelligibility
  - Behavioral speech compensations
    - Supplemental AAC strategies
      - Comprehensive AAC systems
        - Reduce underlying subsystem impairment (if course is improving)

- Moderate to severe reductions in intelligibility
  - Comprehensive AAC systems
  - Re-establish support for speech (if course is improving); reduce underlying subsystem impairment

- No functional speech
  - Comprehensive AAC systems

Intelligibility Cases
Group Discussion of Client
-Intelligibility
  *What factors are affecting intelligibility in this speaker?
-Speaker Focus
  *Speech Subsystems
    -Respiration
    -Phonation
    -Articulation
    -Resonance
-Communication Focus
  *Supplemental Information

W.W.
- A 37-year-old-man who had a brain stem stroke as a result of a collapsed artery with onset date 6-6-98.
- He has dysarthria of speech as a result of the CVA
- This is his 2nd semester at FAU-CDC (although he has had treatment off and on for almost 10 years)

A.F.
- A 32-year-old woman who sustained a traumatic brain injury in 2005 due to a car accident.
- She has dysarthria of speech (and apraxia) as a result of the TBI.
- This is her 4th semester at FAU-CDC
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