What We Can Learn From Speech Recognition Testing In Children Who Are Deaf Or Hard Of Hearing

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Questions?
For any questions during this broadcast, please send an email to:
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Questions will be answered at the end of the presentation.

Overview

• Thinking beyond the audiogram
• Speech recognition assessment
• Using linguistic hierarchy
• Clinical applications

The Audiogram

• A graph of the softest sound that a person can hear at least 50% of the time
• Measured using pure tones
• Used to define type, degree, and configuration of hearing loss
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**Audiogram**

- SOFT
- LOUD
- X = left ear
- O = right ear

**Hearing Thresholds**

- Hearing loss results in loss of audibility for speech and other important sounds.
- Greater hearing loss = more limited audibility

**Speech Recognition**
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**Speech Recognition**

- Presented using headphones or sound field
- Conversational level or higher
- Using recorded words or sentences
- In quiet or with noise

**Clinical Speech Recognition**

- Provides estimate of functional speech understanding
- Diagnostic indicator for type of hearing loss
- Fast and easy to complete
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Limitations Of Speech Recognition

- **Wide range of performance for:**
  - People with hearing loss
  - Children
- **Stimuli are not frequency shaped**
  - Poor speech recognition ≠ poor outcomes
    with hearing aids

Frequency Shaping From Amplification

- **Presentation level (dB)**
  - Maximum performance (75 or 80 dB)
  - Conversational level (60 or 65 dB)
  - Soft conversational level (50 or 55 dB)
- **Testing multiple levels**
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Testing A Range Of Levels

Speech Recognition Factors

• Unaided
  – Without hearing aids, cochlear implant or osseointegrated auditory device.

• Aided
  – With devices

Example Of Aided Testing
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### Aided vs. Unaided Testing

- **Provides evidence of device benefit**
  - Hearing aid (HA)
  - Cochlear implant (CI)
  - Osseointegrated Auditory Device (OAD)

- **Configurations**
  - HA + CI vs. CI alone
  - HA vs. no HA

### Speech Recognition Factors

- **Stimuli**
  - Phonemes
  - Words
    - Monosyllables “bike”
    - Multisyllabic “cowboy”
  - Sentences
    - Vary context
    - Connected discourse and narratives

### Quiet Or Noise

- **Quiet**
  - Baseline speech recognition

- **Noise**
  - Realistic listening situations
    - Types of noise
      - Steady-state (Heating-Ventilation noise)
      - Modulated (Cocktail-party or multi-talker noise)
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Speech Recognition Process

- Audiogram measures detection
  - Present or absent
- Speech recognition requires
  - Audibility
  - Decoding
  - Cognitive Processing
  - Language Skills

Models Of Speech Recognition

Acoustic-phonetic (stimulus) cues
Linguistic / Contextual cues (Knowledge)

Speech Recognition By Age

Stelmachowicz et al. 2000
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Cognitive And Linguistic Skills
- Audibility is necessary
  - Not sufficient
- Children are developing skills into adolescence
  - Phonological
  - Lexical
  - Working memory

Speech Recognition Abilities
- Listening in quiet or in background noise

Children Who Are Hard Of Hearing
- Face all of the same developmental challenges as children with normal hearing
- Also experience:
  - Limited or inconsistent access (audibility)
  - Language delays
  - Different auditory experience
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### Speech Recognition

- **Important diagnostic tool for assessing children who are deaf and hard of hearing**
  - Evidence of device efficacy
  - Can provide supplemental information about how children are using cognitive and linguistic skills

### Language Hierarchy

- **Discourse**
- **Sentences**
- **Words**
- **Phonemes**

### Using Language Hierarchy

- **Consider:**
  - Language skills
  - Speech production
    - Point to picture task?
  - Cognitive skills
    - Working memory (length)
    - Executive function (attention to task)
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**Language Hierarchy**

**Phonemes**

- **No syntax or semantic cues**
- **Phonotactic probability**
  - How often combinations of phonemes occur together in language
- **Word similarity**

**Language Hierarchy**

**Phonemes**

- **Examples:**
  - Ling sounds
  - Vowel-Consonant-Vowel /asa/
  - Consonant-Vowel-Consonant /keet/
  - Sequences /keet/ /boash/ /kood/

**Language Hierarchy**

**Phonemes**

- **Applications:**
  - Detection of specific speech sounds
  - Focus on bottom-up processing
    - Emphasize the acoustic and phonetic cues
  - Examine use of phonotactic probability skills
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**Language Hierarchy**

Words

- **No syntax or semantic cues**
- **Phonotactic probability**
  - How often combinations of phonemes occur together in language
- **Vocabulary**

**Language Hierarchy**

Words

- **Examples:**
  - Phonetically-balanced Kindergarten lists (PBK-50)
  - Word Intelligibility through Picture Identification (WIPI)
  - Early Speech Perception (ESP)

**Language Hierarchy**

Words

- **Applications:**
  - Estimating use of new vocabulary skills
  - Minimal working memory load
  - Quick test (attention)
  - 25-50 items for repeatable results
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Language Hierarchy

- Sentences
  - Syntax and semantic cues
    - Can be manipulated
  - Complexity
  - Vocabulary
  - Working memory

Language Hierarchy

- Sentences
  - Examples:
    - Bamford-Kowal-Bench (BKB) Sentences
      - High predictability
        - He went sailing on a ______
      - Low predictability
        - He thought about the ______

Language Hierarchy

- Sentences
  - Examples:
    - Zero predictability
      - Ducks run fast car
    - Word sequences
      - Map ball ate drive
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Language Hierarchy

- **Sentences**
  - **Applications:**
    - How does the child use sentence syntax and semantics?
    - How does the child listen with a realistic cognitive load?

Language Hierarchy

- **Discourse**
  - Multiple sentences, narrative, or story
  - Highest cognitive load
  - Realistic for school-based learning

Language Hierarchy

- **Examples**
  - Listening and retelling stories
  - Test of narrative language
    - Expressive or Receptive
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### Language Hierarchy

**Applications**
- Demonstration of wide range of auditory, linguistic and cognitive skills
- Create social contexts by involving peers

### Language Hierarchy

- Assess skills by manipulating stimulus context in speech recognition
- Contrast skills by adding or taking away information
  - High → Low predictability sentences
  - Nonwords → Words

### Case Example

- 10 year-old male
- Struggling in school
  - All academic areas
- History of frequent ear infections during childhood
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Case Example - Audiogram

Case Example – Speech Recognition

- BKB Sentences in quiet
  - 84% keywords correct
- BKB Sentences in multi-talker noise
  - 48% keywords correct

Case Study - Conclusion

- Recommendations
  - Hearing aid
  - FM system in the classroom
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Speech Recognition

• Factors that influence speech recognition
• Using the linguistic hierarchy
• Examples of practical applications

References


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A production of the Lied Learning & Technology Center at Boys Town National Research Hospital

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