Assessing speech perception in children: Current practice and considerations

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Overview

• Background
  – Speech language pathology in Sweden
• Definition
• Requirements
  – Variables to consider
• Challenges
  – Information at different levels
• Clinical groups
15-11-30

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Sweden, northern Europe

Uppsala, the cradle of Sweden
Uppsala (1286) and Uppsala university (1477)

Tänka fritt är stort
Men tänka rätt är större

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Uppsala högar – The Uppsala mounds

Lake Mälaren, where we skate during winter

Goce, Santi and Veronika
winter 2015
Speech Language Pathology - Sweden

• Started in 1965 at Karolinska Institutet, Stockholm
• 2015 celebrated it’s 50th anniversary
  – At present 1900 authorized SLPs
  – 80 PhDs
• 4 years of academic studies (professional degree)
  – Studies in Phonetics, Linguistics, Psychology, Medicine, Speech and Language Pathology including clinical practice and a Master's thesis
Predecessor:
Alfhild Tamm, 1912: “Hearing dumbness”

- “Hearing dumbness” is described in the chapter on aphasia, also ”psychological deafness”
  - Undeveloped sense for word timbre = “word dumbness”

- Dr Tamm separates hearing dumbness (hörstumhet) from deafness (dövstumhet)
  - Motor
  - Sensory

- Caused by reduced memory and attention

- Important to support with written language
Definition

**Speech perception** also called speech recognition, refers to how (well) people use auditory and/or visual information to understand spoken messages

N. Tye-Murray, 2014
Washington University School of Medicine in St. Louis
New Zealand’s University of Canterbury
Definition

Speech perception - a key skill

Provides important information regarding overall auditory perception skills

Can be of value in outlining the prognosis of
Speech
Language
Reading
Cognition
Challenges

• Speech perception cannot be directly measured but only inferred from a child’s responses

• If the child has insufficient cognitive resources, is unable or unwilling to participate there will be a gap between his/hers performance and actual speech perception ability
Requirements of assessments

Speech perception measures form the basis for:

- Amplification and programming strategies in hearing aids and cochlear implants
- Language learning strategies
- Auditory and/or perceptual training
- Following children’s progress
Requirements of assessments

Assessing speech perception in children

Amplitude

Time (ms)

Sentence: 3206.65 ms
Two-syllable word: 723.66 ms
One-syllable word: 533.13 ms
Phoneme: 120.17 ms
Formant transition: 20.08 ms

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Requirements of assessments

Accurate measurements of a child’s ability to perceive:

**Phonetic segments and patterns**
- /ba/, /da/, /ga/
  - Tallal, 1980

**Words**
- Nakeva von Mentzer et al., ongoing
  - Minimal word pairs,
  - 7 phonetic categories,
- Close procedure

**Sentences**
- HINT – Nilsson, 1994
- LiSN, Cameron & Dillon, 2007

**Connected discourse**
- Best et al., 2015
  - Ongoing speech comprehension test
  - Short everyday passages
  - On-the-go questions

Vance & Martindale, 2012
Nonword discrimination task

<table>
<thead>
<tr>
<th>Voice fricative contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>/æsə/</td>
</tr>
<tr>
<td>/æzə/</td>
</tr>
<tr>
<td>/izə/</td>
</tr>
</tbody>
</table>

LiSN, Cameron & Dillon, 2007
Variables to consider

**Internal**
- Chronological age
- Cognitive level
- Language and vocabulary level

**External**
- Designation of an appropriate response task
- Utilization of reinforcement
- Memory load inherent in the task

**Methodological**
- Administration of the test
- Live versus recorded stimuli
- Open-set versus closed-set test construction

Results obtained may not adequately represent a listener’s performance in natural conversations

Articulatory errors cannot easily be differentiated from perceptual errors

-Shy children

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Variables to consider

Character of the speech stimuli
Age of acquisition

Word frequency effects
Lexical neighborhood effects
Speech information at different levels

- **Rhythm, chunks, feet, and segments**

**Prosodic features**
- Stress and intonation
  - Vowel duration
  - Metrics
  - Syllables
  - Onset-rhyme

**Consonants**
- Chunks > the syllable
Hearing vs speech discrimination acuity

The phonemes are in our brain!
The auditory-phonetic interface

• So far, no theory has been able to reliably indicate what features in the signal are the crucial ones for perceiving the intended message.
The auditory-phonetic interface

Top down

Bottom-up

- Interaction of these levels in heard speech perception
We must not forget...

And the uniqueness of human language
So what do we need?

• A combination of measures that assess different levels of the speech signal

as well as

• Test results from several areas of perception, each of which thought to reflect some aspect of the underlying construct of speech perception

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Clinical groups of children of interest to the SLP

• Children with…
  – Speech sound disorder
  – Language impairment
  – Dyslexia (word decoding difficulties that may occur in a variety of different groups of children)
  – Autism
  – Attention Deficit Hyperactivity Disorder
  – Hearing loss
Perceptual deficits in clinical groups

• **Poor Temporal Resolution of perceptual systems** (Tallal & Piercy, 1973)
  – Effects particularly detrimental to language learning
  – Acoustically less salient contrasts, i.e. segments in unstressed positions or of short duration particularly affected

• **Poor amplitude resolution** (Goswami et al, 2002, 2004, 2011)
  – Has implications for phonemic categorisations

• **Poor neural synchrony, inhibition** (Kraus et al., 2000, Schwoch et al., 2015a,b,c)
  – The neural coding of speech in noise plays a fundamental role in language development
Was Tallal entirely wrong?

Brief sounds, Short Inter Stimulus Intervals

- Lawrence Leonard states (2000, p. 145): “The conclusion that children with SLI have difficulty processing brief or rapidly presented stimuli seems indisputable. These findings are so consistent and demonstrable across tasks and stimulus variations that it is difficult to imagine that they are not an important piece of the SLI puzzle.”
Amplitude rise time, illustrated
Goswami et al., dyslexia

• Excellent phonetic discrimination (changes of formant transition duration)

But difficulties with the basic auditory processing of

• Slower amplitude modulation cues

Difficulties in perceiving phonetic contrasts on the basis of amplitude envelope cues
Kraus et al., White-Schwoch et al.

Background noise degrades the neural processing of speech in preschoolers

• Is worse in response to consonant transitions relative to vowels
  – degraded in terms of magnitude, timing, spectral content, temporal coding of the speech envelope, and with respect to the stability across stimulus trials
Instead of testing children’s sentence and word recognition in noise, they suggest using a

- Composite measure of the neural coding of consonants in noise, integrating
  - peak latency, response stability, and representation of the harmonics
- Measure suprathreshold responses to consonants in noise
- Tax the developing auditory brain to reveal systematic individual differences in inhibitory processing.
Conclusion

Speech perception assessments are important but...

Results need to be interpreted in relation to a variety of underlying internal and external factors.

Interdisciplinary work is essential!
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Thanks for listening!

Questions?