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Assessing speech perception in children: Current practice and considerations

Cincinnati Children's Medical Hospital

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SWEDEN

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Overview

- Background
  - Speech language pathology in Sweden
- Definition
- Requirements
  - Variables to consider
- Challenges
  - Information at different levels
- Clinical groups

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Sweden, northern Europe

Uppsala, the cradle of Sweden

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Uppsala (1286) and Uppsala university (1477)

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Uppsala högar – The Uppsala mounds

Lake Mälaren, where we skate during winter

Goce, Santi and Veronika winter 2015

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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

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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**

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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

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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

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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

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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

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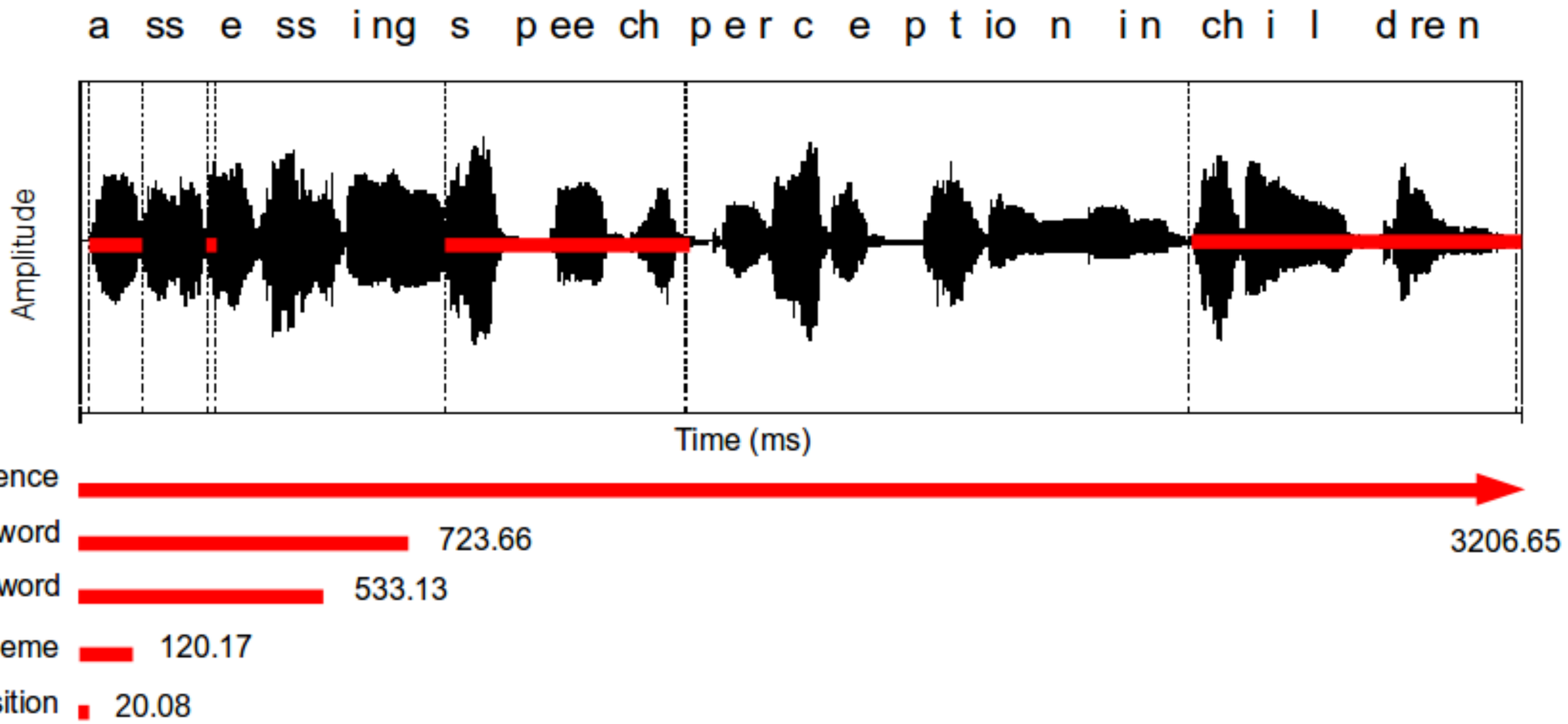
Requirements of assessments



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Requirements of assessments

/ba/, /da/, /ga/
Tallal, 1980
/ba/, /βa/
Goswami, 2011
White-Schwoch et al., 2015
/da/

Accurate measurements of a child's ability to perceive:

Phonetic segments and patterns

Vance & Martindale, 2012
Nonword discrimination ta

Voice fricative contrast	
/'ɑsə/	/'ɑzə/
/'isə/	/'izə/

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

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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

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Speech information at different levels

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

Prosodic features

Stress and intonation

Vowel duration

Metrics

Syllables

Onset-rhyme

Chunks > the syllable

Consonants

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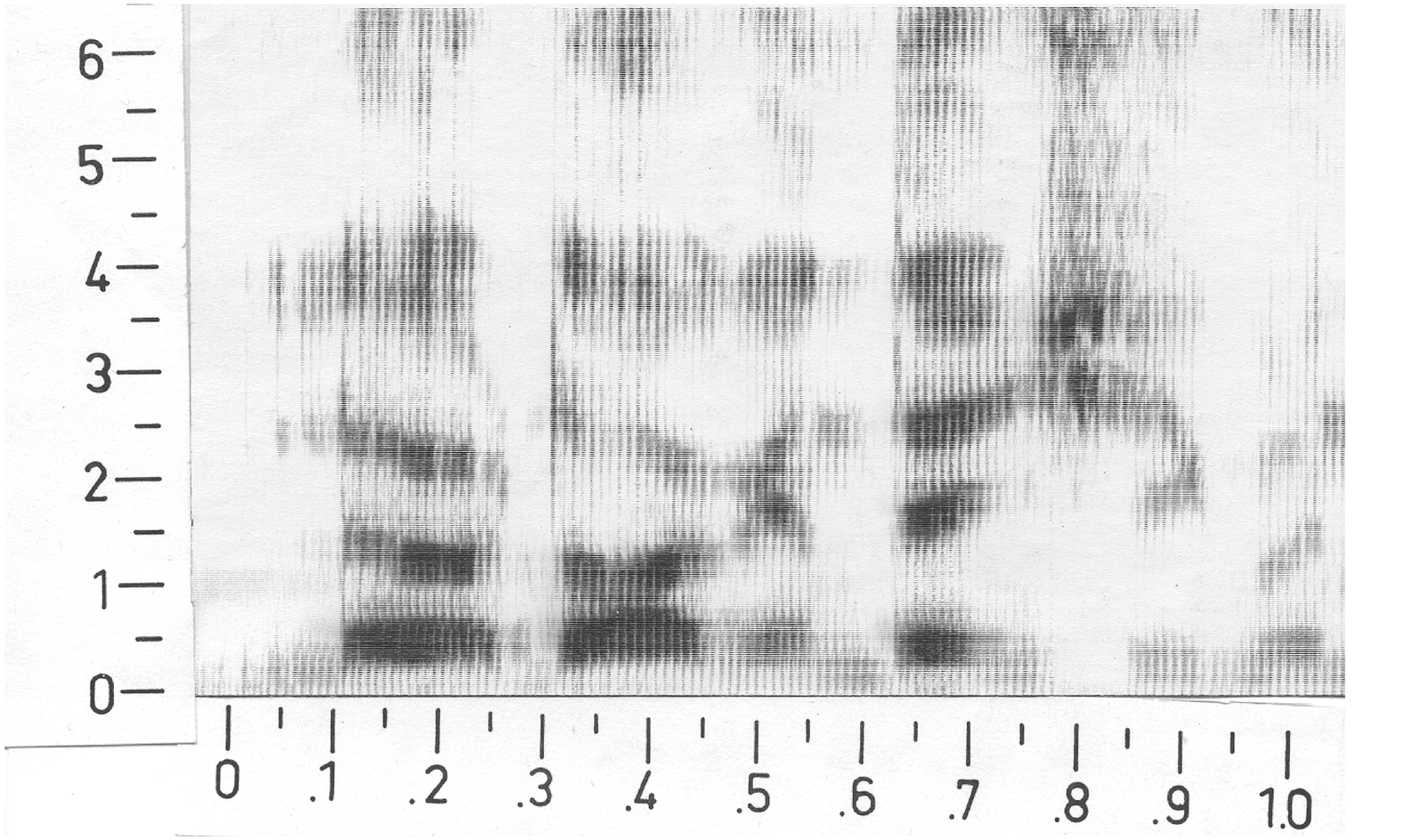
Hearing vs speech discrimination acuity

The phonemes are in our brain!



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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

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We must not forget…

The beauty of the auditory organ

Responsible for exceptional sound analysis

And the uniqueness of human language

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So what do we need?

- A combination of meaures 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

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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

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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."

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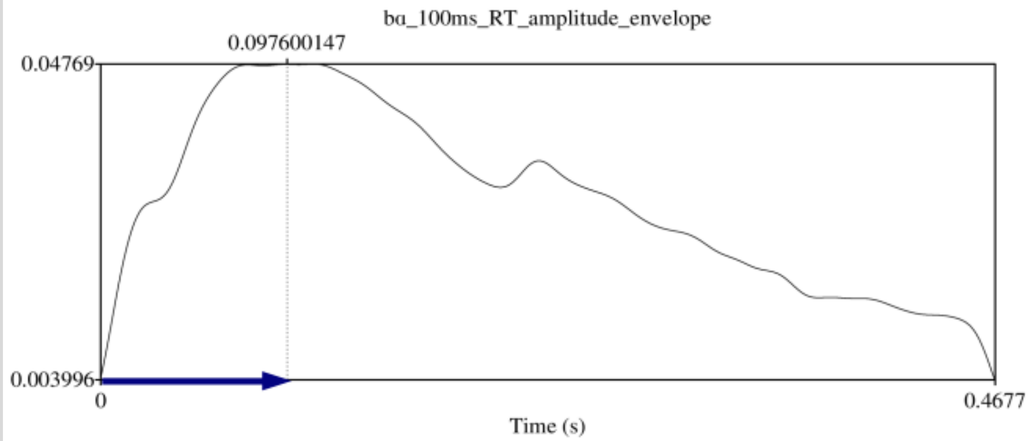
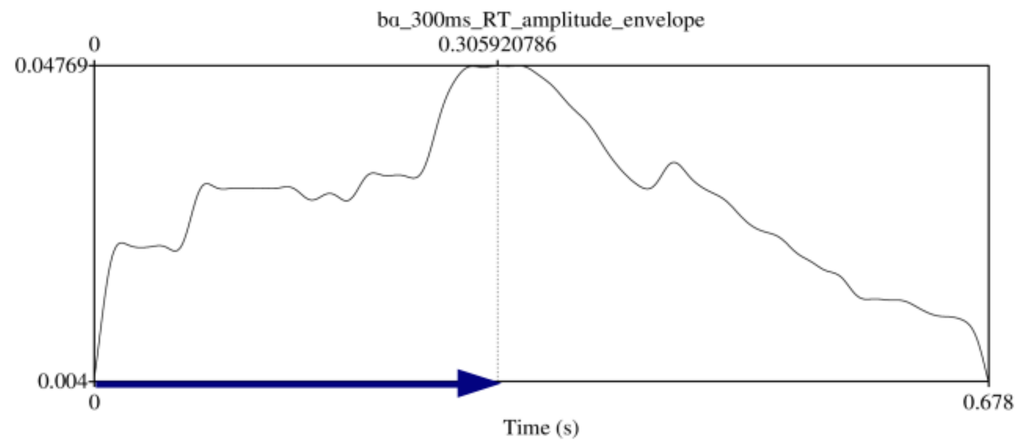
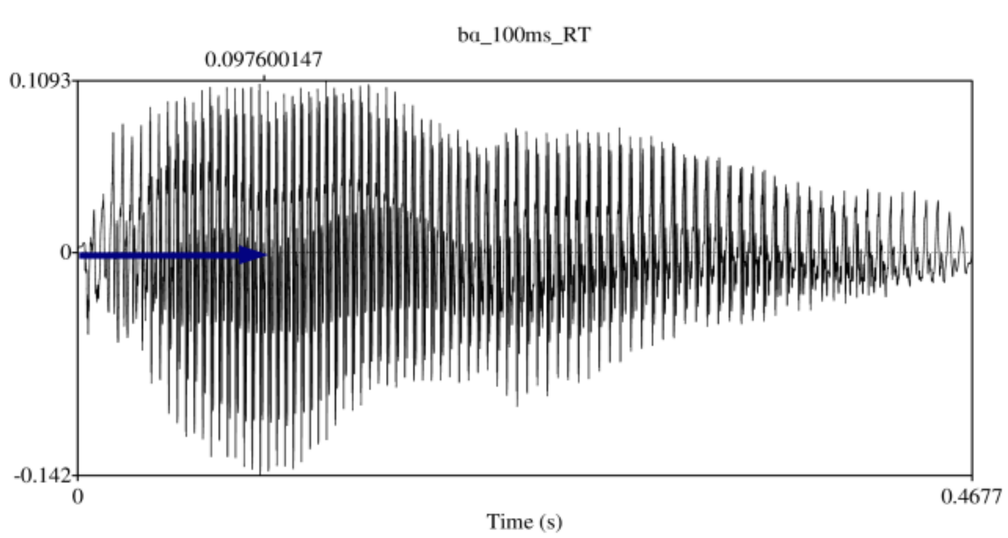
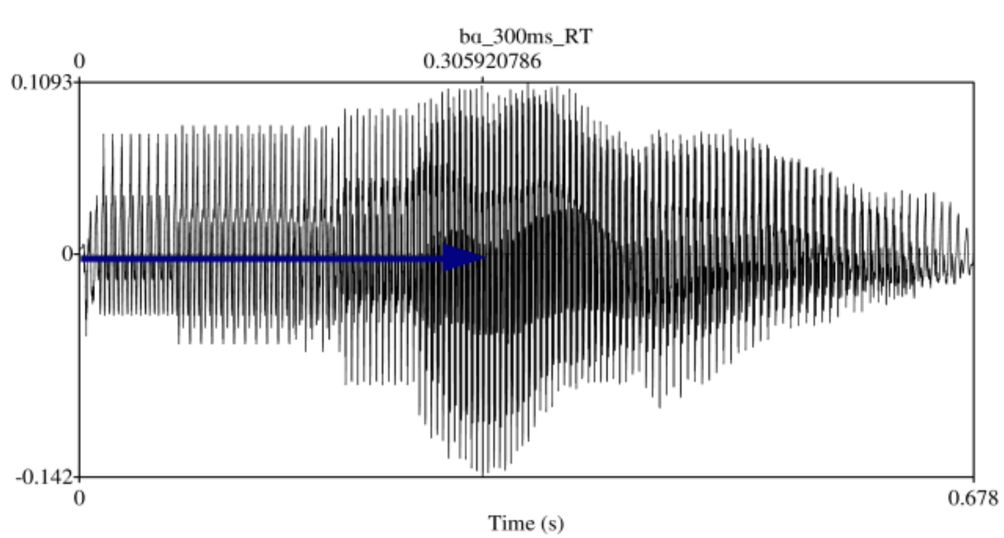
Amplitude rise time, illustrated









amplitude rise time (RT)/ attack

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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

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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

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Kraus et al., White-Schwoch et al

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.

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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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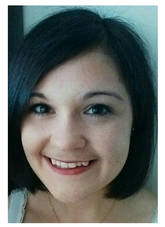

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Thanks for listening!

Questions?