Children With Cochlear Implants: Cognitive and Language Factors Towards Speech Understanding in Noise

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I declare that I have no proprietary interest in any product, instrument, device, service, or material related to this presentation.

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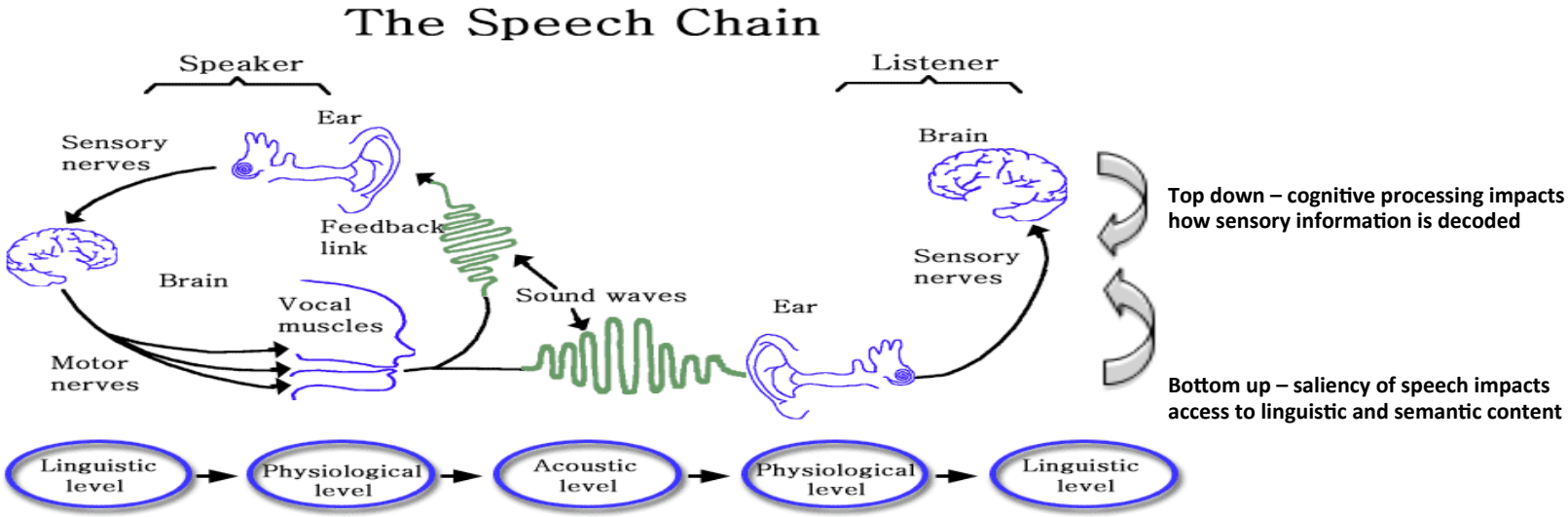

Denes & Pinson, 1993

The problem: speech in noise

- Cochlear implant (CI) users listen through a degraded system (impaired ear, electrical hearing with limited spectral and temporal detail)
- Speech understanding is made worse by noise and reverberation
- Speech in noise understanding is more difficult among young children; auditory development continues through adolescence (Werner, 2007)
- Opportunities for improving speech in noise exist

- *Acoustic enhancements: clear speech*
  - characterized by a wide range of acoustic-articulatory adjustments
  - enhances intelligibility for various listener populations
    - Adults with hearing loss, children with and without learning impairments, low proficiency non-native listeners (Bradlow et al., 2003; Bradlow and Bent 2002, Cassie et al., 2001)

- *Semantic enhancements: highly predictive, contextual information*
  - Children less effective in noise compared to adults (Nittrouer & Boothroyd, 1990; Elliot, 1979)
    - Young children's limited knowledge
  - Children equally effective as adults when noise levels adjusted (Fallon, Trehub & Schneider, 2002)
    - Comparable gains from context

Goals:

- Word recognition in adverse conditions (noise) for children and adult CI listeners and control groups of children and adults with normal or near normal hearing (NH)
- Do CI children and adults apply similar strategies for listening to speech in noise compared to NH children and adults
  - Do these groups use acoustic enhancements, semantic enhancements independently and combined?

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- Participants:
  - Production:
    - 2 adults (1 male , 1 female)
    - 60 HP + 60 LP sentences
    - Conversational and clear speaking style
    - Total of 480 sentences
  - Perception
    - 15 children with cochlear implants (7;0 -12;0 years of age)
    - 18 children with normal hearing (6;9 – 12;6 years of age)

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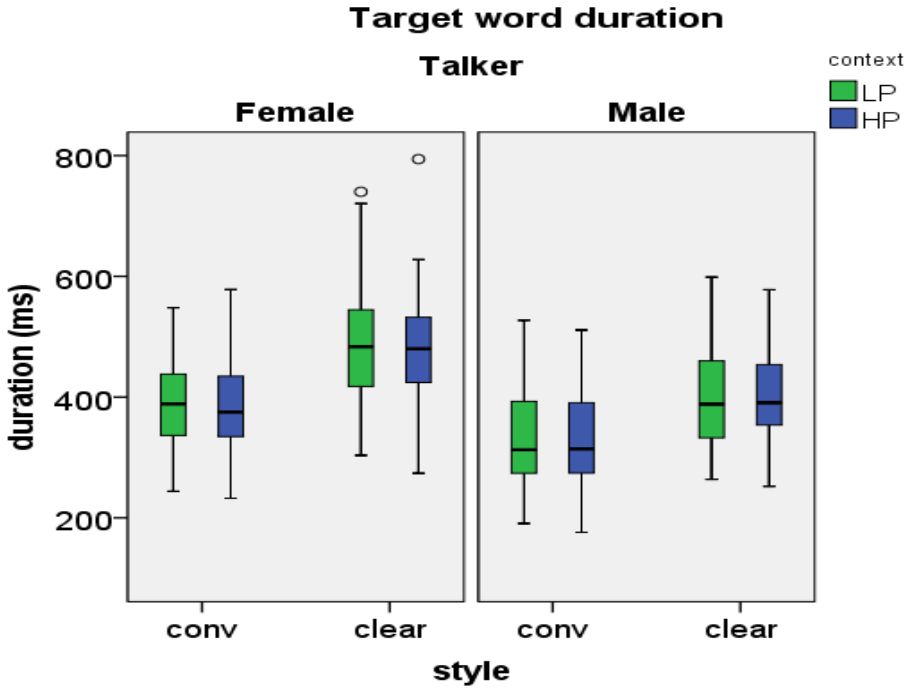
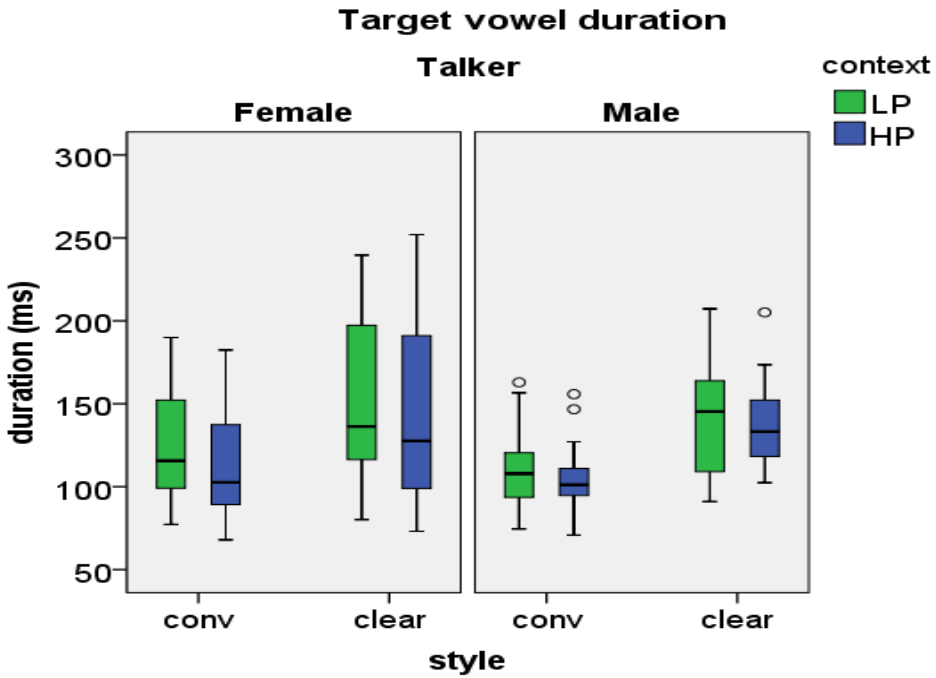
- Materials:
  - 120 sentences designed specifically for use with children (Fallon, Trehub & Schneider, 2002)
    - 60 high predictability (HP) sentences spoken in conversational speech, and again in clear speech
    - 60 low predictability (LP) sentences spoken in conversational speech, and again in clear speech
  - **HP**
    - Mice like to eat **cheese**.
    - Rain poured from the **cloud**.
  - **LP**
    - He looked at the **cheese**.
    - We pointed at the **cloud**.

Results: Production



Results: Production



Participants: Experimental Tasks

NH Children (n = 18)

- Hearing thresholds better than 20 dB HL .5-4KHz

CI Children (n = 15)

- 11 cochlear (6 bilateral, 5 bimodal), 4 AB (2 bilateral, 2 bimodal)
- The cochlear children all used ADRO and ASC
- Tested in their preferred listening program

Procedures

1) Cognitive, language testing
   - LEITER-R Performance Scale (non-verbal IQ)
   - Oral Written Language Scale (OWLS)
   - Wide Range Assessment of Memory and Learning (WRAML)
     - Attention subtest
   - Comprehensive Test of Phonological Processing (CTOPP)
     - Phonological awareness
     - Phonological memory
     - Phonological naming

2) Speech in noise testing
   - 240 sentences: blocked by talker, style and context; order of blocks pseudo-random
   - Repeat the final word; recorded by the experimenter
   - Target sentences mixed with spectrally matched noise
   - Noise presented at 60 dB SPL (A)
   - SNR determined individually by adaptive pre-test

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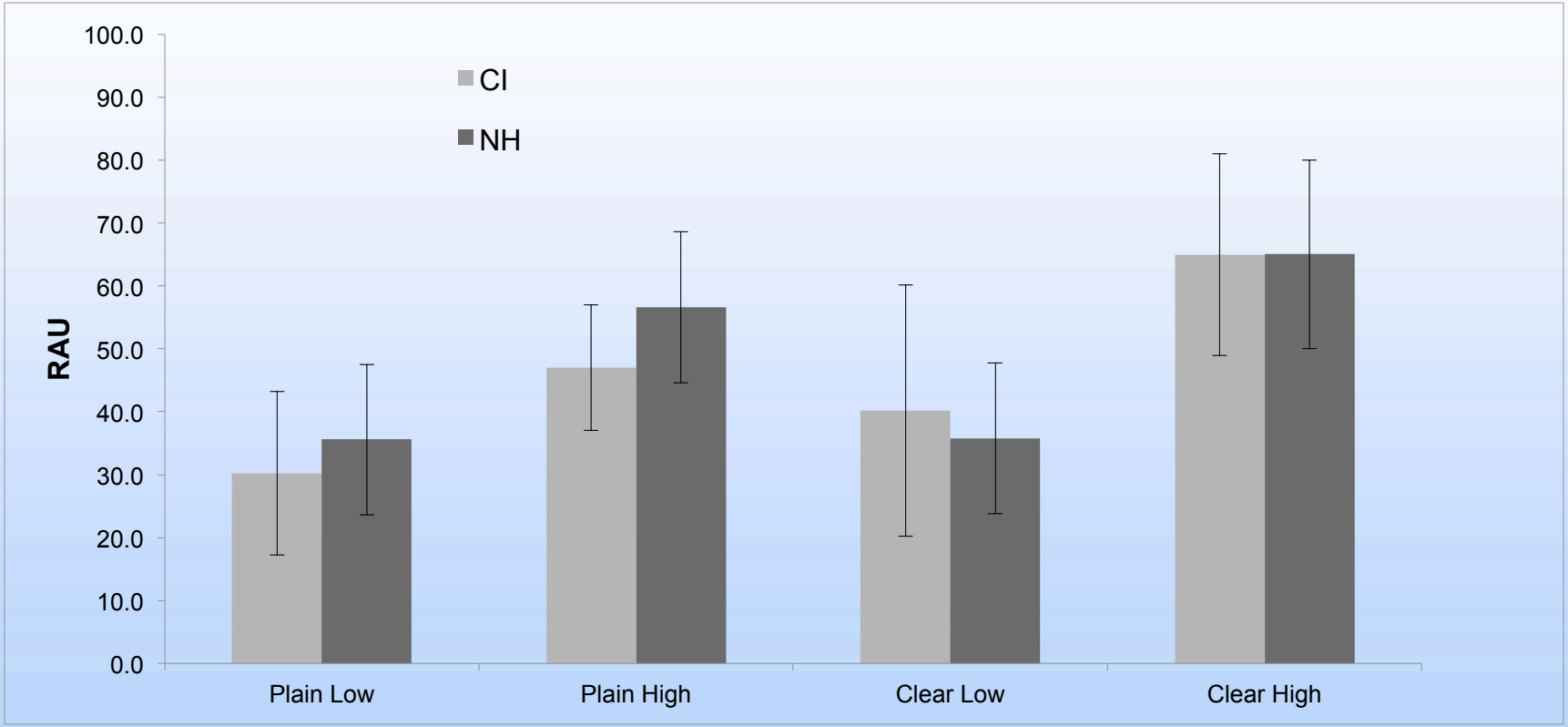
Results: Clear Speech



Cognitive and language tests

		Standard Score	
		NH	CI
OWLS			
	Receptive	104.6*	92.0 (SD 14.9)
	Expressive	109.5*	97.0 (SD 15.0)
WRAML			
	Attention	102.6	94.7 (SD 15.0)
CTOPP			
	Awareness	103.0*	89.3 (SD 15.9)
	Memory	93.3	86.4 (SD 12.7)
	Naming	100.8	93.0 (SD 12.0)
LEITER			
	Non-verbal	104.4	97.9 (SD 13.0)

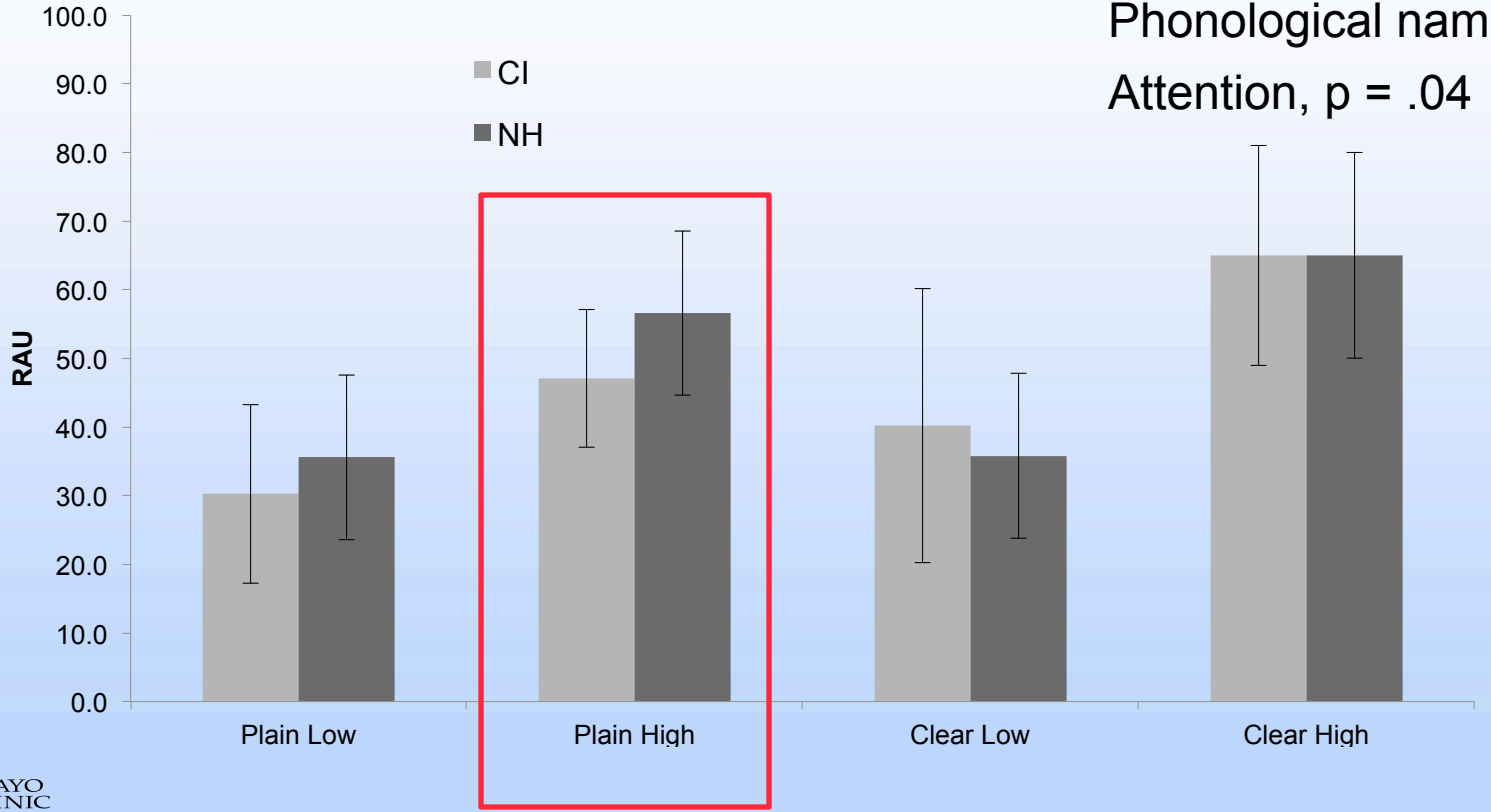
Results: Clear Speech

Phonological awareness, p = .04

Phonological memory, p = .009

Phonological naming, p = .02

Attention, p = .04



Summary

- Children with cochlear implants and children with normal hearing benefit from acoustic enhancement of speech
- Benefits from semantic enhancement are realized in combination with clear speech
- This may demonsrate that improved lower level sensory input allow access to higher order processing

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