

# Word Learning in Children with Hearing Loss

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# Why study word learning?

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- Children with hearing loss typically have reduced vocabularies compared to children with normal hearing.
- UNHS has produced a new population of children with hearing loss
  - More, better, and longer access to the auditory signal



# What we've learned...

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- Children with hearing loss and children with language impairment have similar word learning outcomes but for different reasons
  - HL: Quality of the acoustic signal
  - LI: Cognitive factors
- Lexical development appears to be delayed ~2 years in children with hearing loss

# What we'd like to know...

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- How a child's hearing loss (elevated hearing thresholds) affects word learning
- How access to the acoustic signal (amplification) affects word learning

# Word Learning Paradigms

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- Learning Performance Paradigm
  - Performance after a fixed number of exposures to a new word
- Learning Rate Paradigm
  - Number of exposures necessary to learn a new word

# Learning Performance

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- “Rapid Word-Learning in Normal-Hearing and Hearing-Impaired Children: Effects of Age, Receptive Vocabulary, and High-Frequency Amplification”

Pittman, Lewis, Hoover & Stelmachowicz (2005) E&H

- Purpose

- Characterize word-learning in children with normal hearing and children with hearing loss
- Characterize the effects of stimulus bandwidth on word learning

# Novel-Word Construction

		Place							
		Bilabial	Labio-dental	Dental	Alveola	Post Alveola	Palatal	Velar	Glottal
Manner	Plosive	p b			t d			k g	
	Nasal	m			n			ŋ	
	Fricative		f v	θ ð	s z	ʃ ʒ	ç ʝ		h
	Approximate				r		j		
	Lateral Approximate	w			l				

# Novel-Word Construction

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p b

t d

k g

m

n

ŋ

f v

θ ð

s z

ʃ ʒ

ç ʝ

h

r

j

w

l

# Novel-Word Construction

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b a i r I l

v o j I ŋ

j u ʒ æ p

z i k I n

d i w I m

t a i ð u s

θ o g I ʃ

h u ç I f

# Novel-Word Construction

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bayrill

vojing

youzzap

zeekin

deewim

tathus

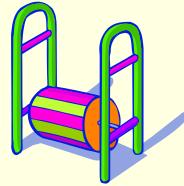
thogish

hoochiff

# Novel-Word Construction

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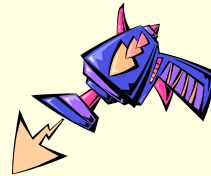
bayrill



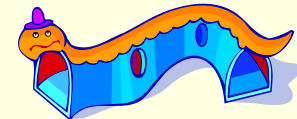
vojing



youzzap



zeekin



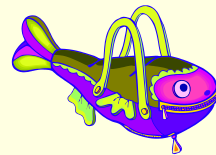
deewim



tathus



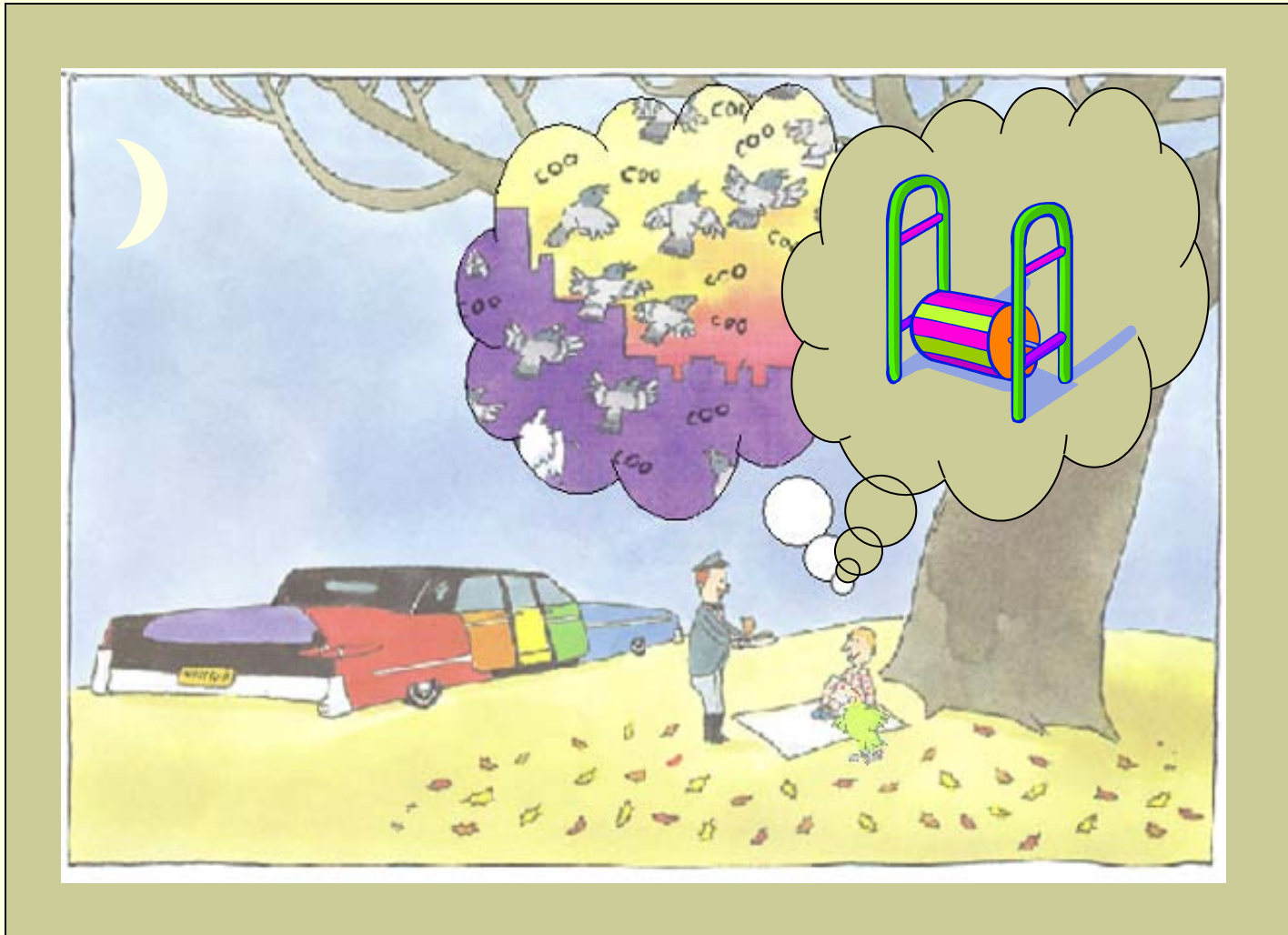
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# Story Construction

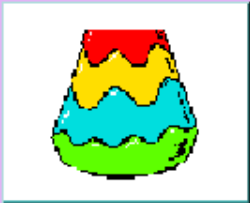


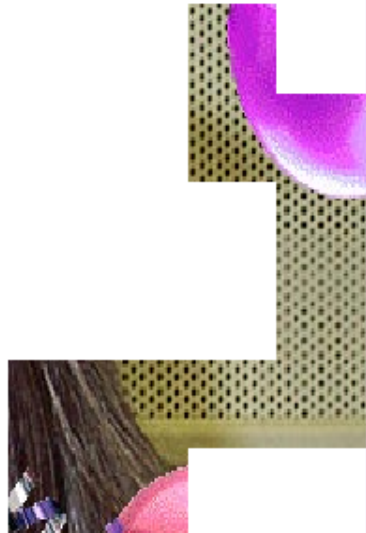
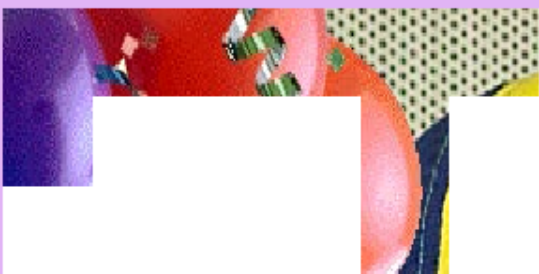
# Story Presentation

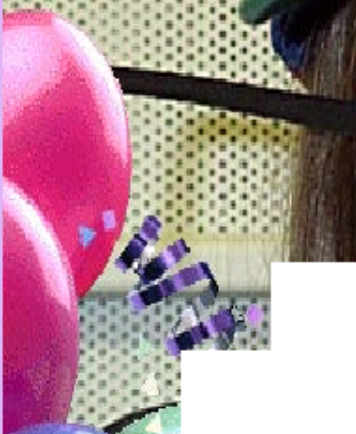
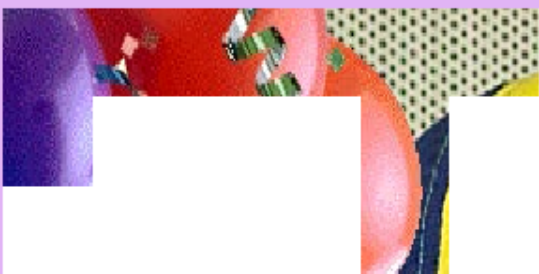
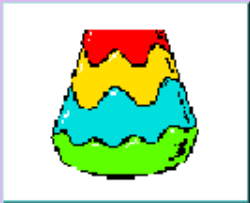
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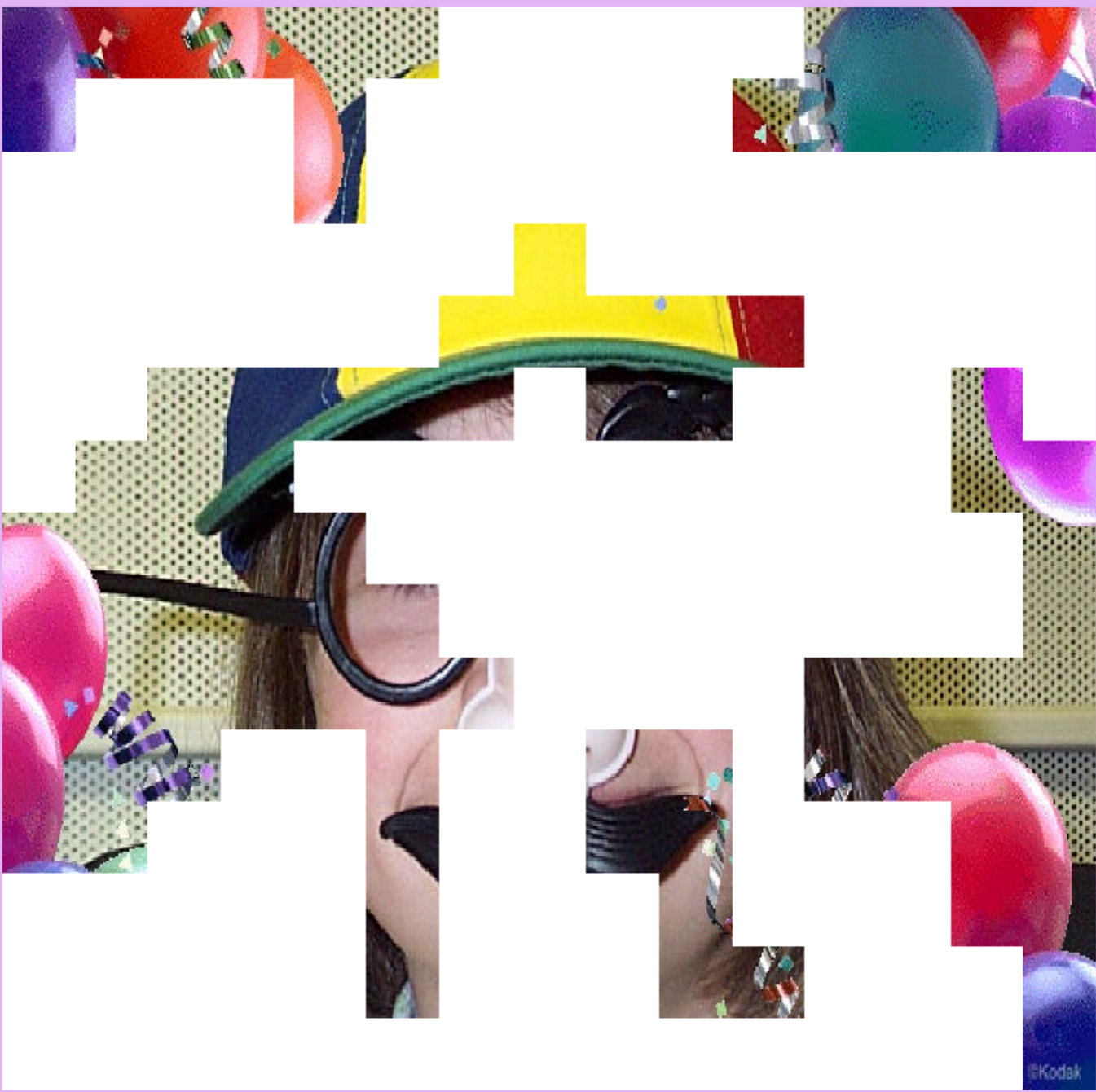
- Bandwidth conditions
  - Standard (LPF 4 kHz)
  - Extended (LPF 9 kHz)
- Each word was presented 3 times in the 4-minute story.
- The story was presented twice.
- Word-learning parameters
  - 8 words
  - 6 presentations each
  - 8 minute period









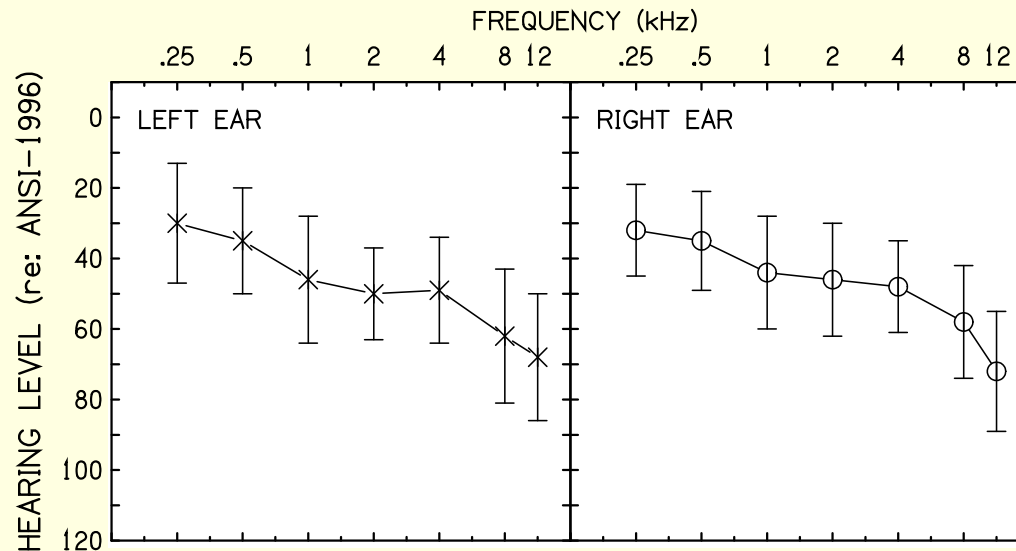






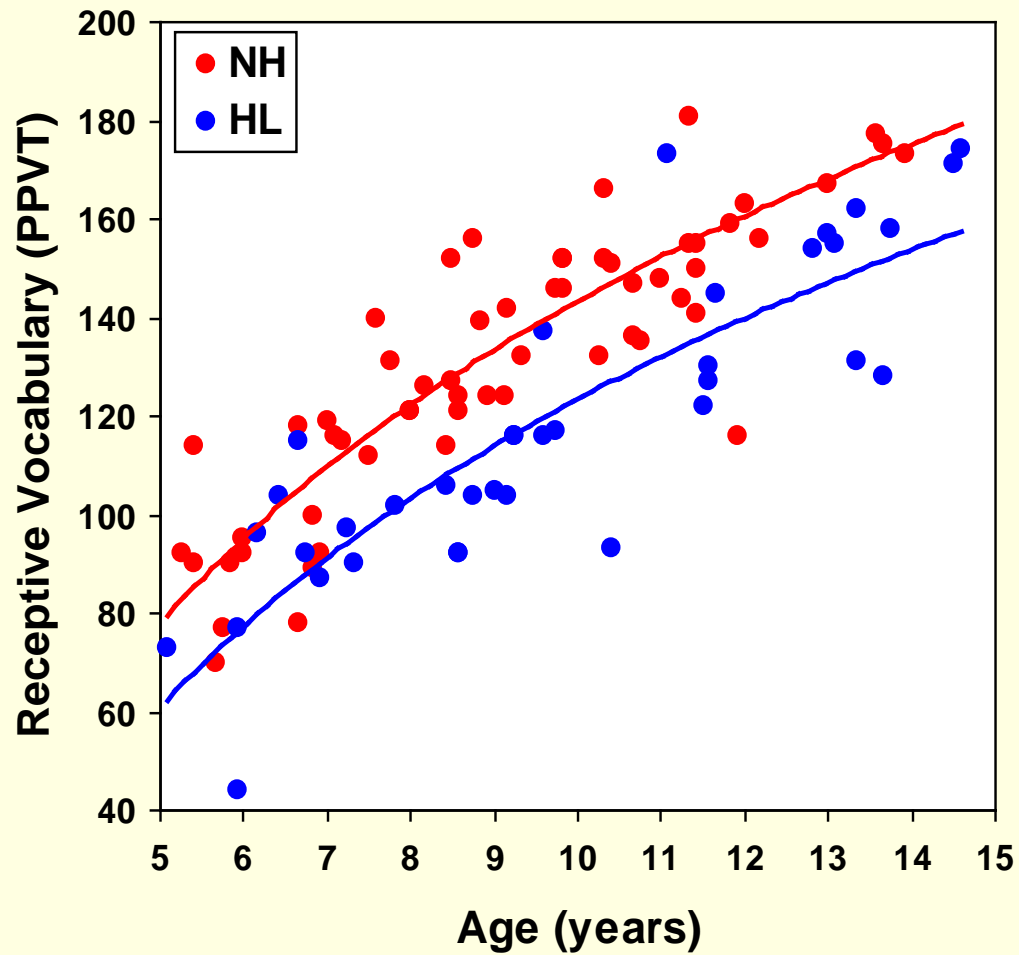
# Participants

- 97 Children between 5- and 14-years-old
  - 60 Normal Hearing (mean age: 9yrs, SD: 2yrs)
  - 37 Hearing Loss (mean age: 9yrs, SD: 2yrs)

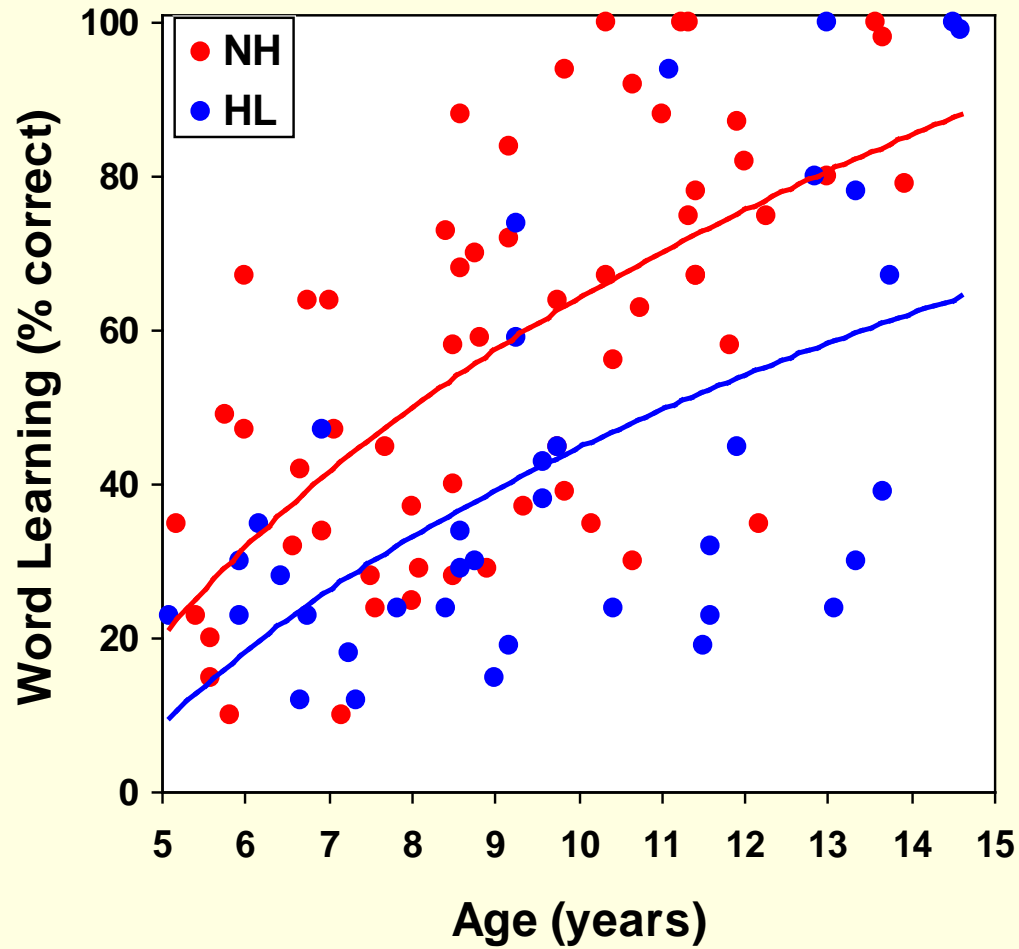


- Estimated receptive vocabulary (PPVT)

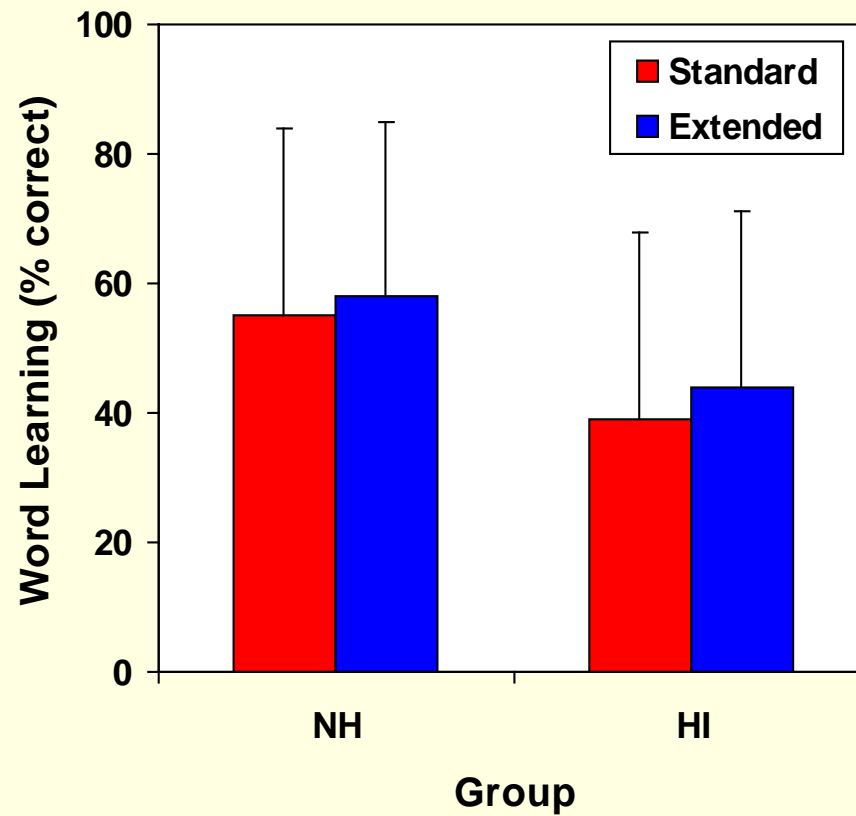
# Results



# Results



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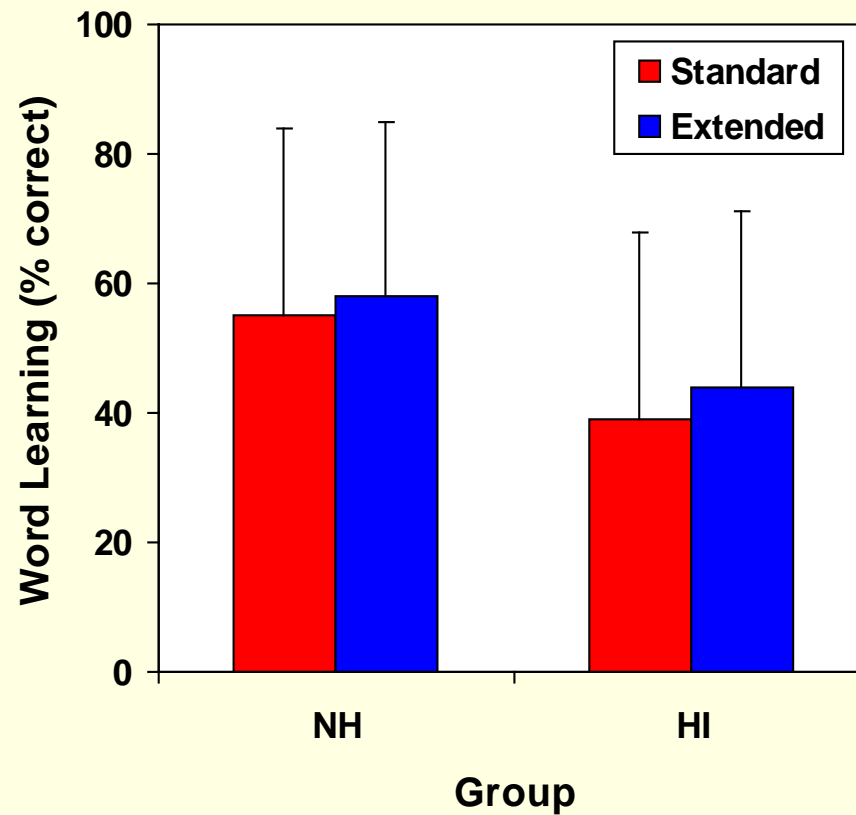


# Conclusions

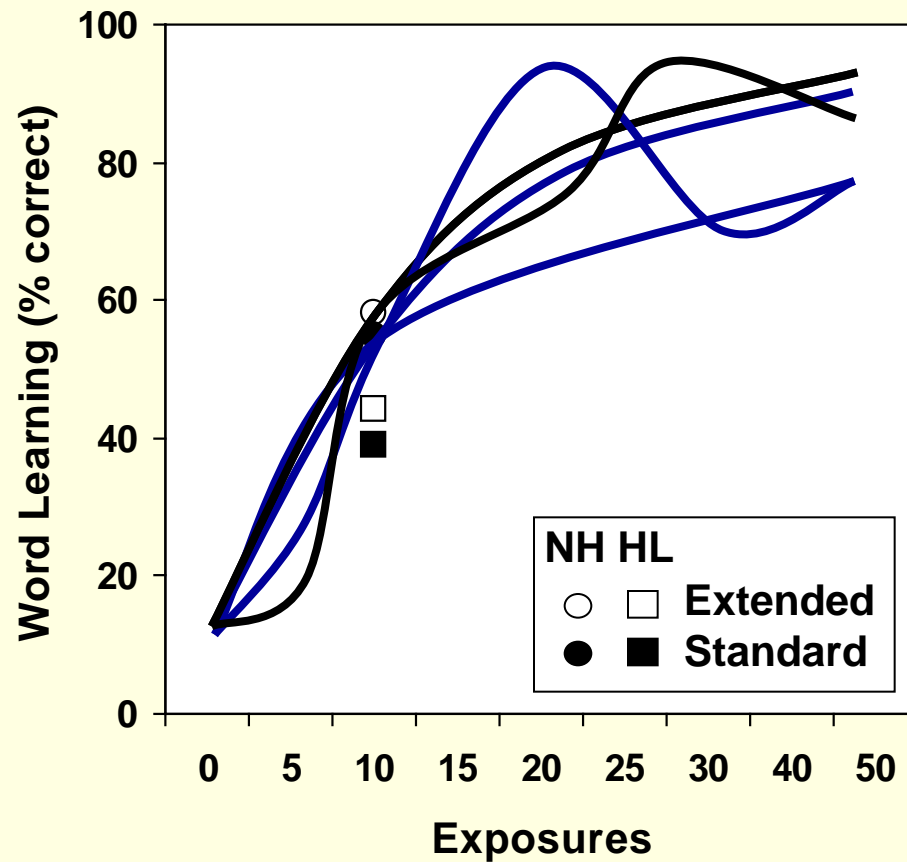
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- Given the same number of exposures, children with normal hearing learned more words than the children with hearing loss.
- An extended bandwidth did not significantly improve word learning in either group.

# What really happens?



# What happens over the long term?



# Word Learning Rate

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- “Short-term word learning rate in children with normal hearing and children with hearing loss in limited and extended high-frequency bandwidths”  
Pittman (June 2008) JSLHR

- Purpose

- To determine the rate of word learning in children with normal hearing and children with hearing loss.
  - Rate defined as the number of exposures necessary to achieve 70% performance
- To determine the effect of bandwidth on learning rate.

# Novel-Word Construction

		Place							
		Bilabial	Labio-dental	Dental	Alveola	Post Alveola	Palatal	Velar	Glottal
Manner	Plosive	p b			t d			k g	
	Nasal	m			n			ŋ	
	Fricative		f v	θ ð	s z	ʃ ʒ	ç ʝ		h
	Approximate				r		j		
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# Novel-Word Construction

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m t d  
n  
f θ s z ∫ h  
l

# Novel-Word Construction

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s a θ n ə d

d a z t ə l

f a s n ə ʃ

s t a m ə n

h a m t ə l

# Novel-Word Construction

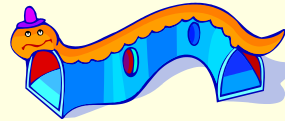
Sothnud



Standard Extended



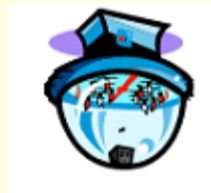
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Fosnush



Stomun

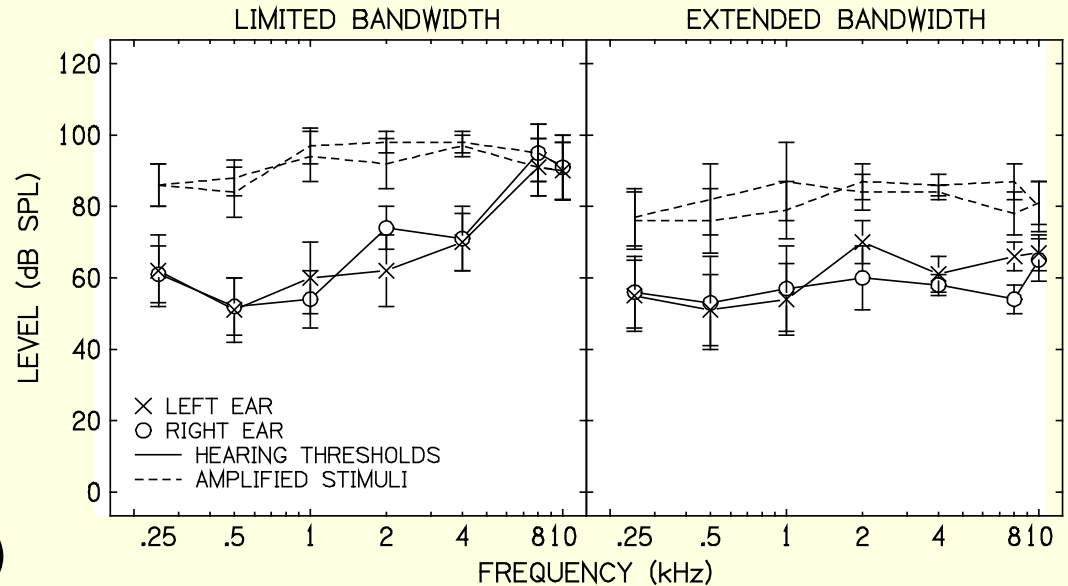


Homtul



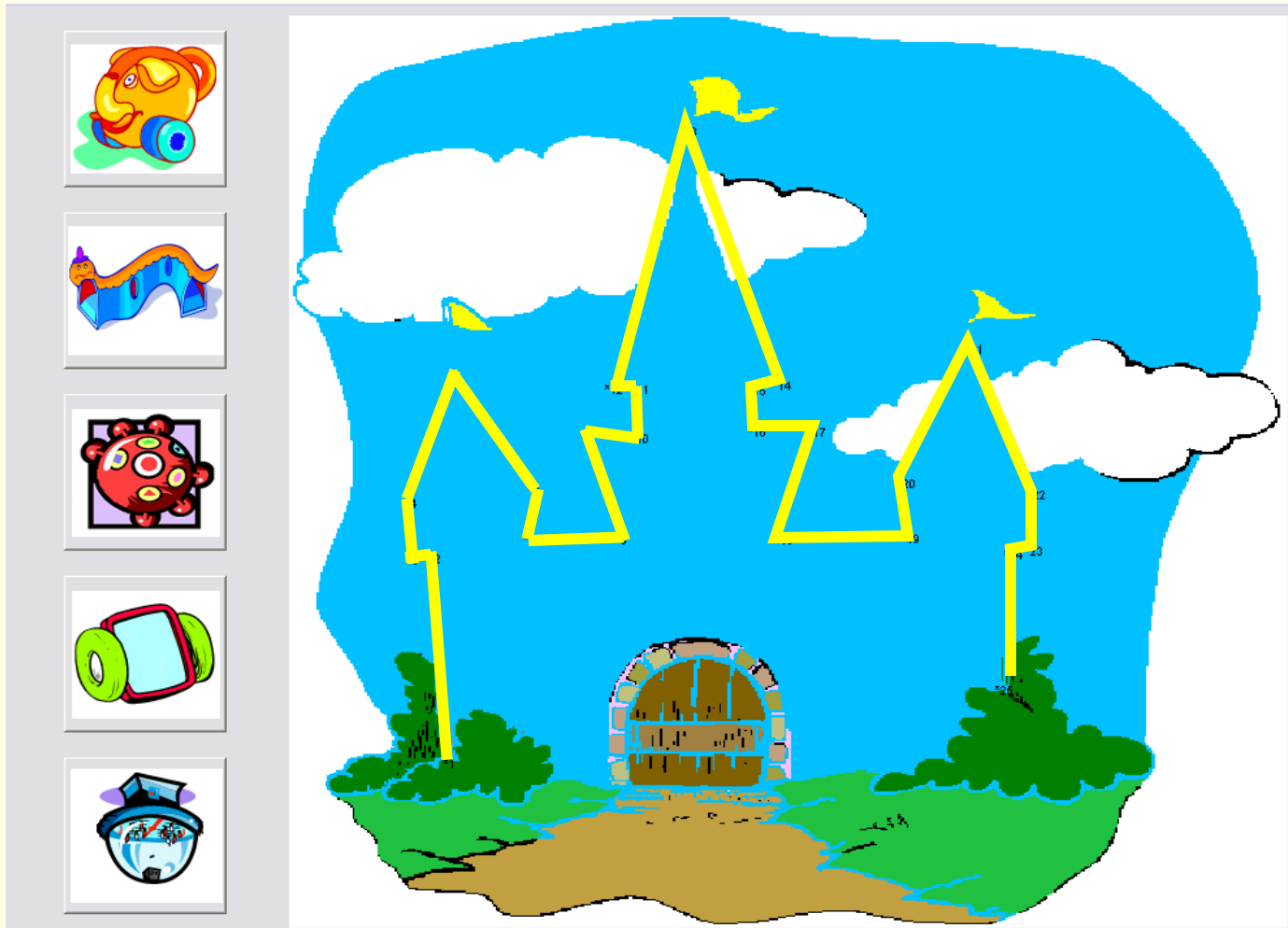
# Method

- Children
  - 36 with NH
  - 14 with HL
  - 8-10 yrs of age
- Bandwidths
  - Standard (4kHz)
  - Extended (9kHz)

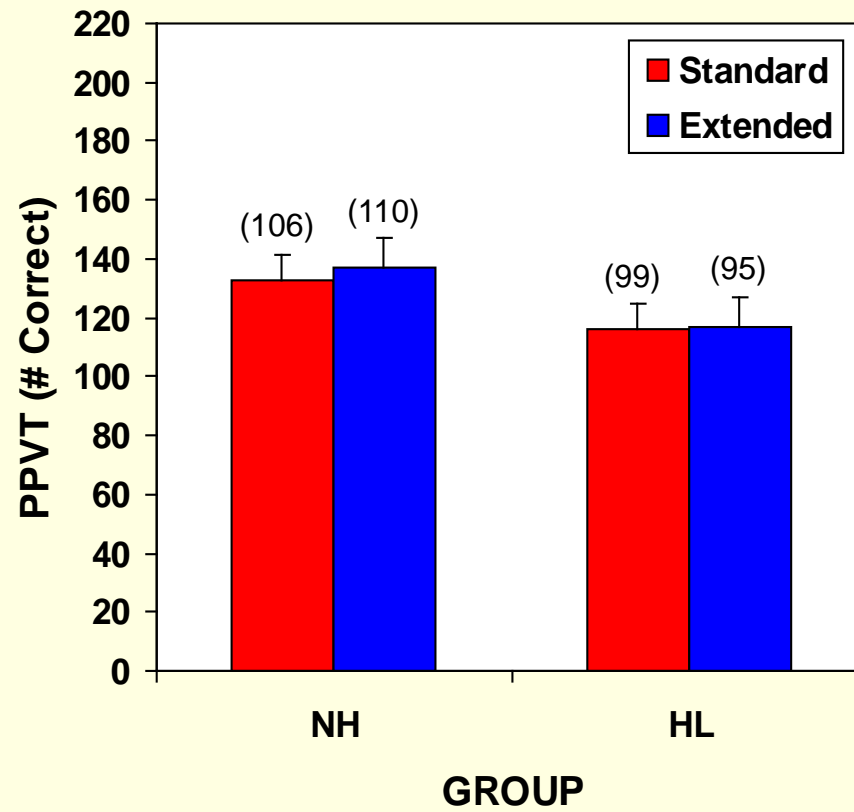


- Half the children learned the words in the standard bandwidth and half in the extended bandwidth
- 150 randomized trials (5 words x 30 repetitions)

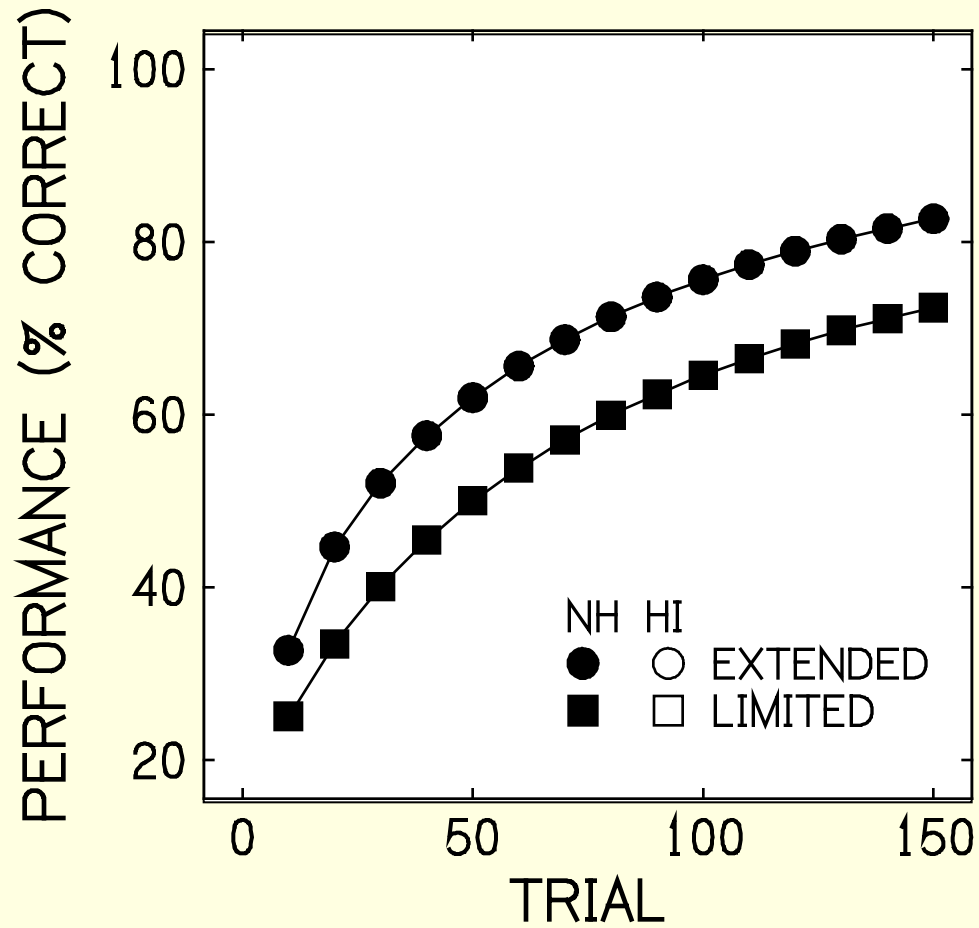
# Learning Game



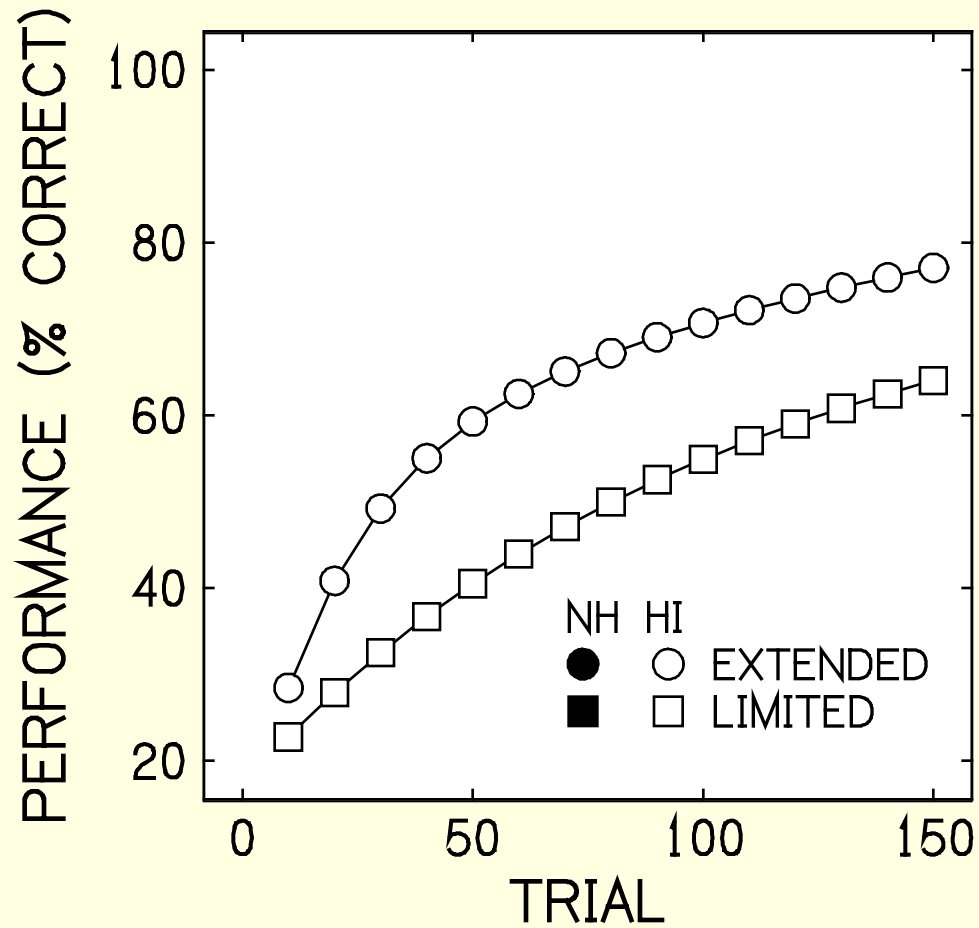
# Results



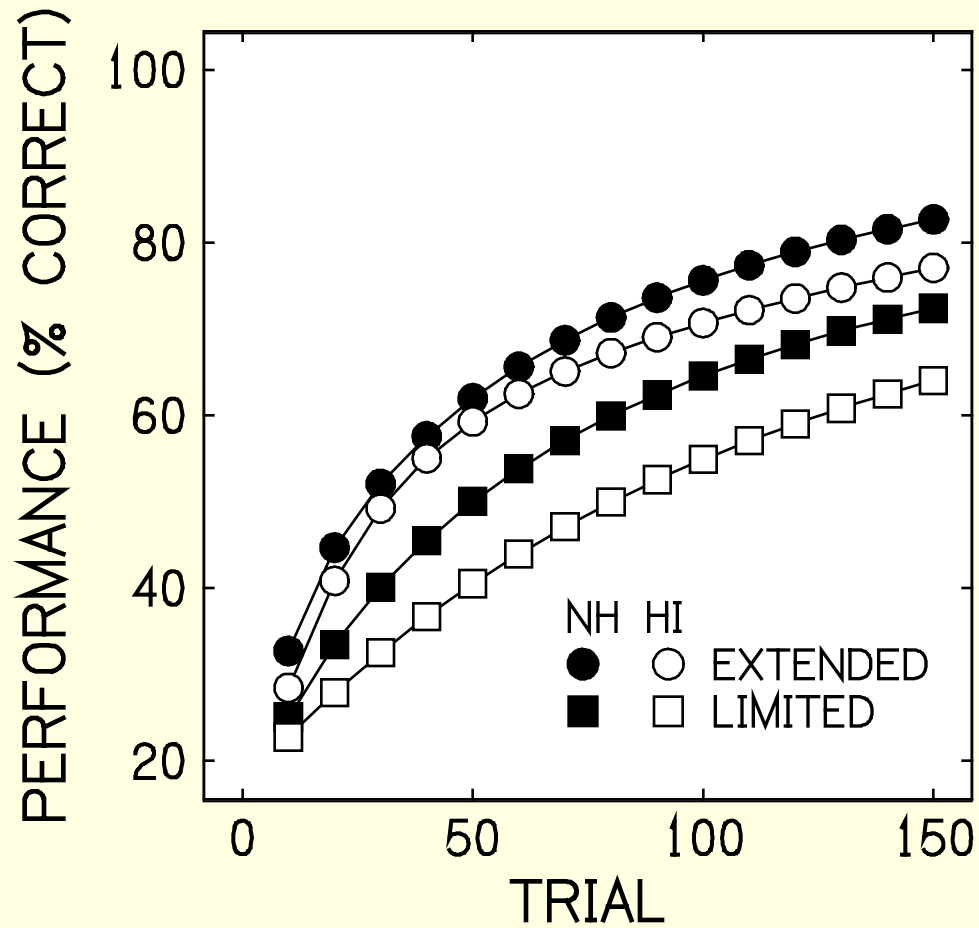
# Results



# Results



# Results



# Results

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## Number of Trials to Learn 5 New Words

	Normal Hearing	Hearing Loss
Standard	43	121
Extended	20*	72

# Results

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## Number of Trials to Learn 1 New Word

	Normal Hearing	Hearing Loss
Standard	16	27
Extended	5*	10

# Conclusions

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- Children with hearing loss require more exposures to learn a new word than children with normal hearing.
  - As much as 5x the exposures.
- Minor acoustic properties can impact long-term word learning.
  - Nothing beats a high quality signal.

# In the Future...

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- Simulating hearing loss to determine effects of elevated thresholds on word learning.
- Learning Rate paradigm will allow us to quickly assess different hearing-aid, signal processing characteristics.



Thank you