

*High-Frequency Amplification:  
Sharpening the Pencil*

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# How high is high-frequency?

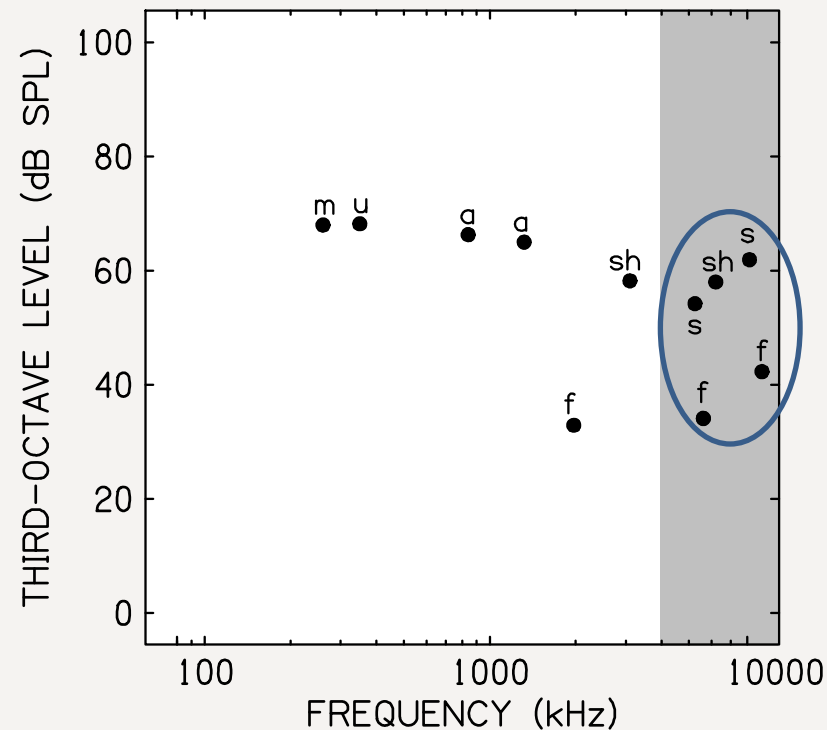
- Hearing Aid Studies :  $\leq 6$  kHz
  - Adults  
(Buckwald et al, 1991; Ching et al 1998; Plyer & Fleck, 2006; Mackersie et al, 2004; Simpson et al, 2005)
- Laboratory Studies : 4-10 kHz
  - Adults  
(Hogan & Turner, 1998; Horwitz et al 2008; Moore et al, 2008; 2010; Ricketts et al, 2008; Turner & Cummings, 1999)
  - Children  
(Pittman et al, 2005; 2008; Stelmachowicz et al, 2001; 2002; 2007; 2008)

# How high is high-frequency?

- Hearing Aid Studies :  $<6$  kHz
  - Determine benefit that can be achieved with commercial devices
  - Determine long-term benefit
  - Limited frequency range
- Laboratory Studies : 4-10 kHz
  - Determine benefit of the full range of speech frequencies
  - Limited to short-term exposure



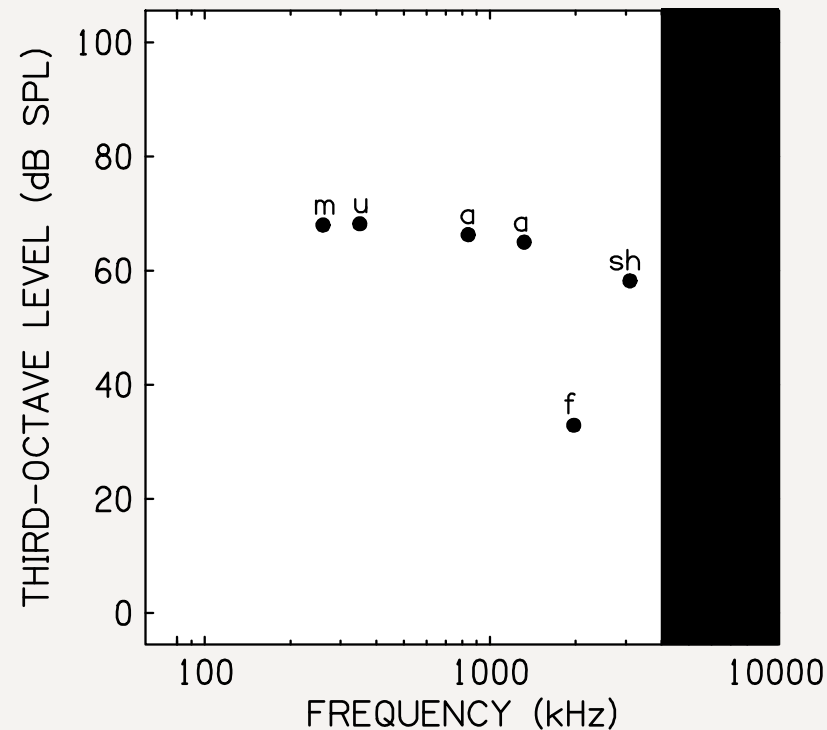
# What acoustic-phonetic information occurs 4-10 kHz?



Boothroyd et al (1994)



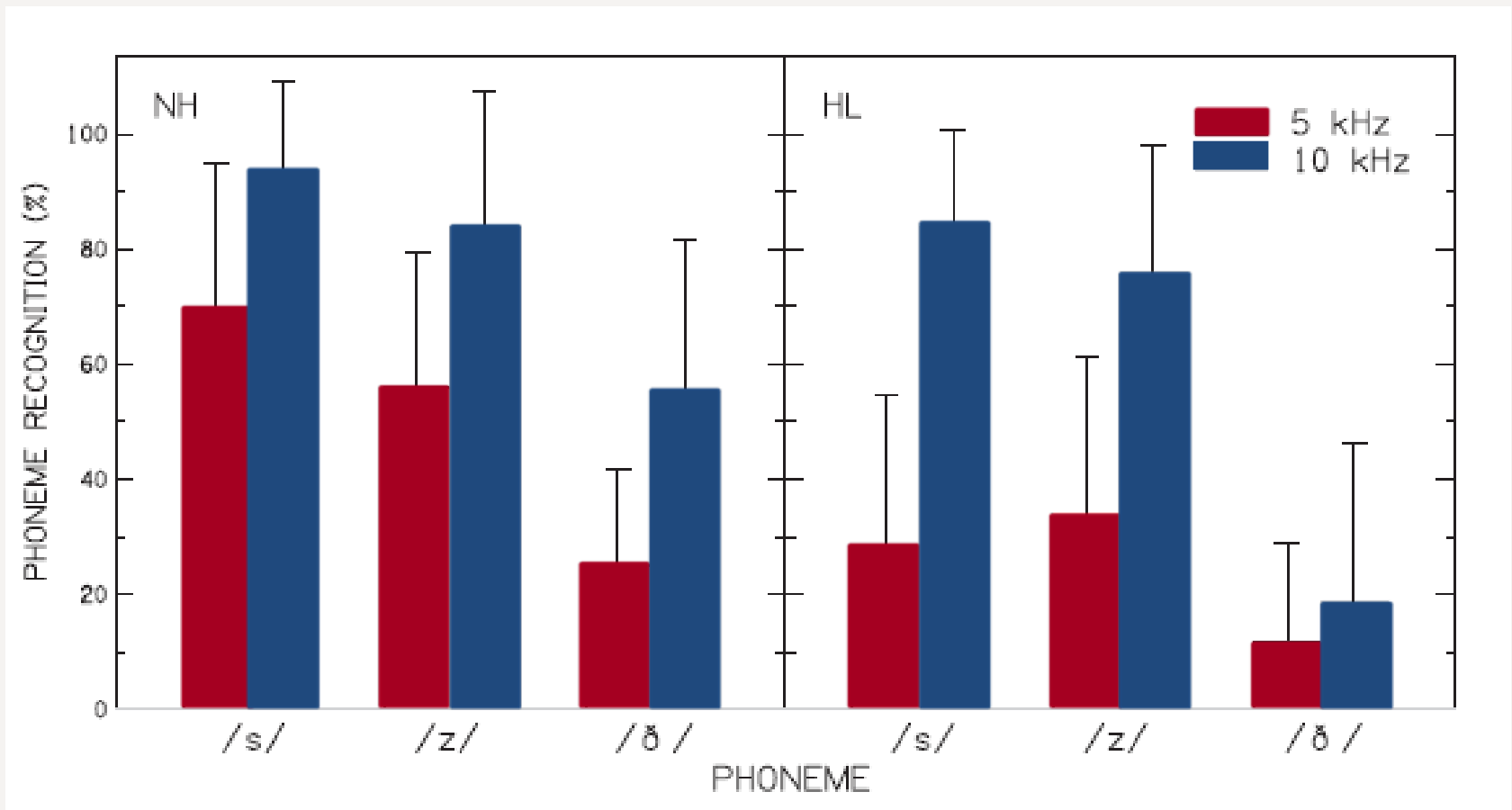
# Can children do without this high-frequency information?



Boothroyd et al (1994)

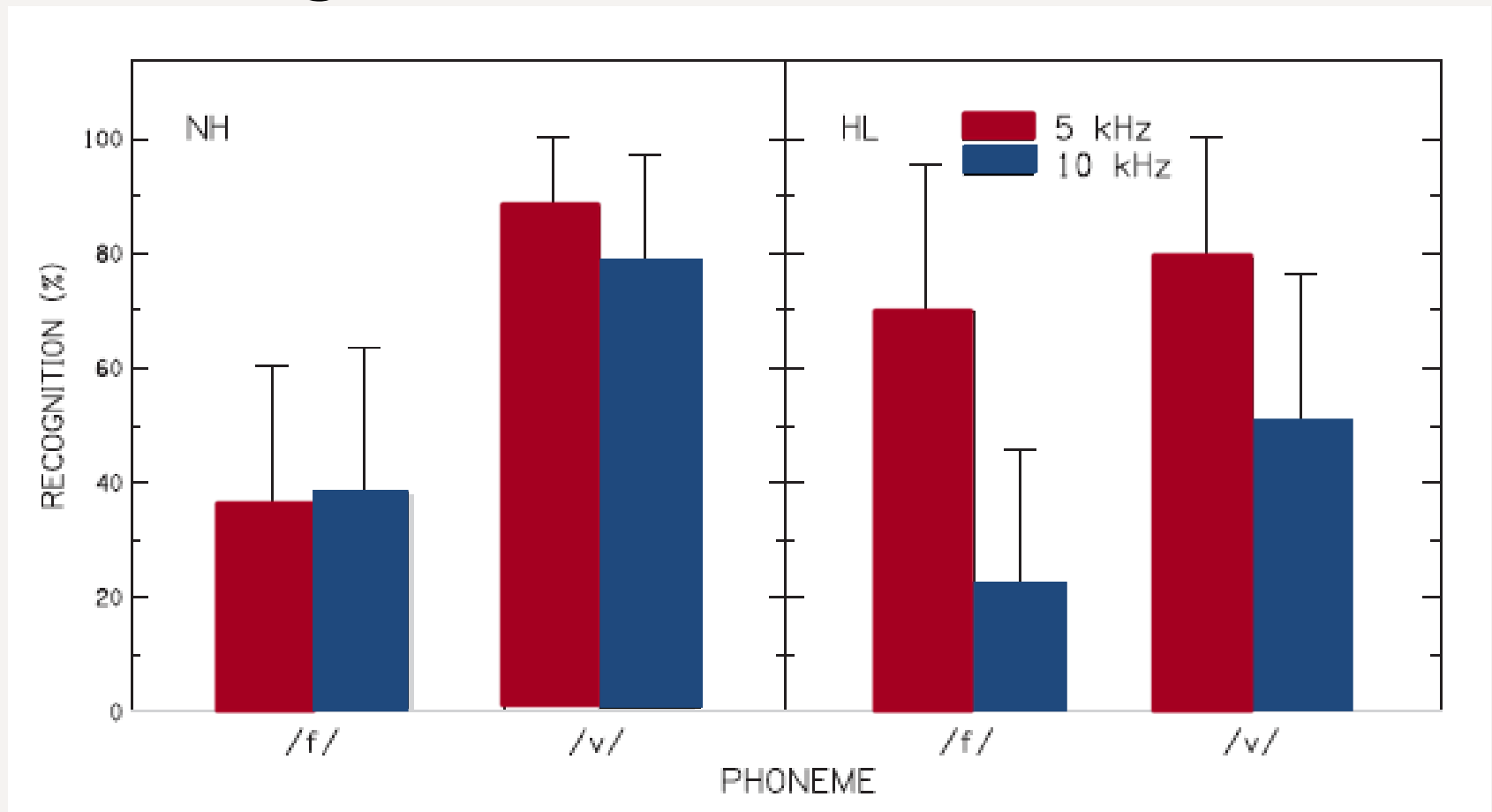


# Can children do without this high-frequency information?



Stelmachowicz et al (2007)

# Can children do without this high-frequency information?



Stelmachowicz et al (2007)

# Does HF information impact other areas of communication?

- Indirect evidence re: speech & language development
  - Effects fricative production (Moeller et al, 2007)
    - Slower rate of production development
  - Effects morpho-syntactic development (Moeller et al, 2010)
    - Inconsistent and less accurate use of the morpheme /s/



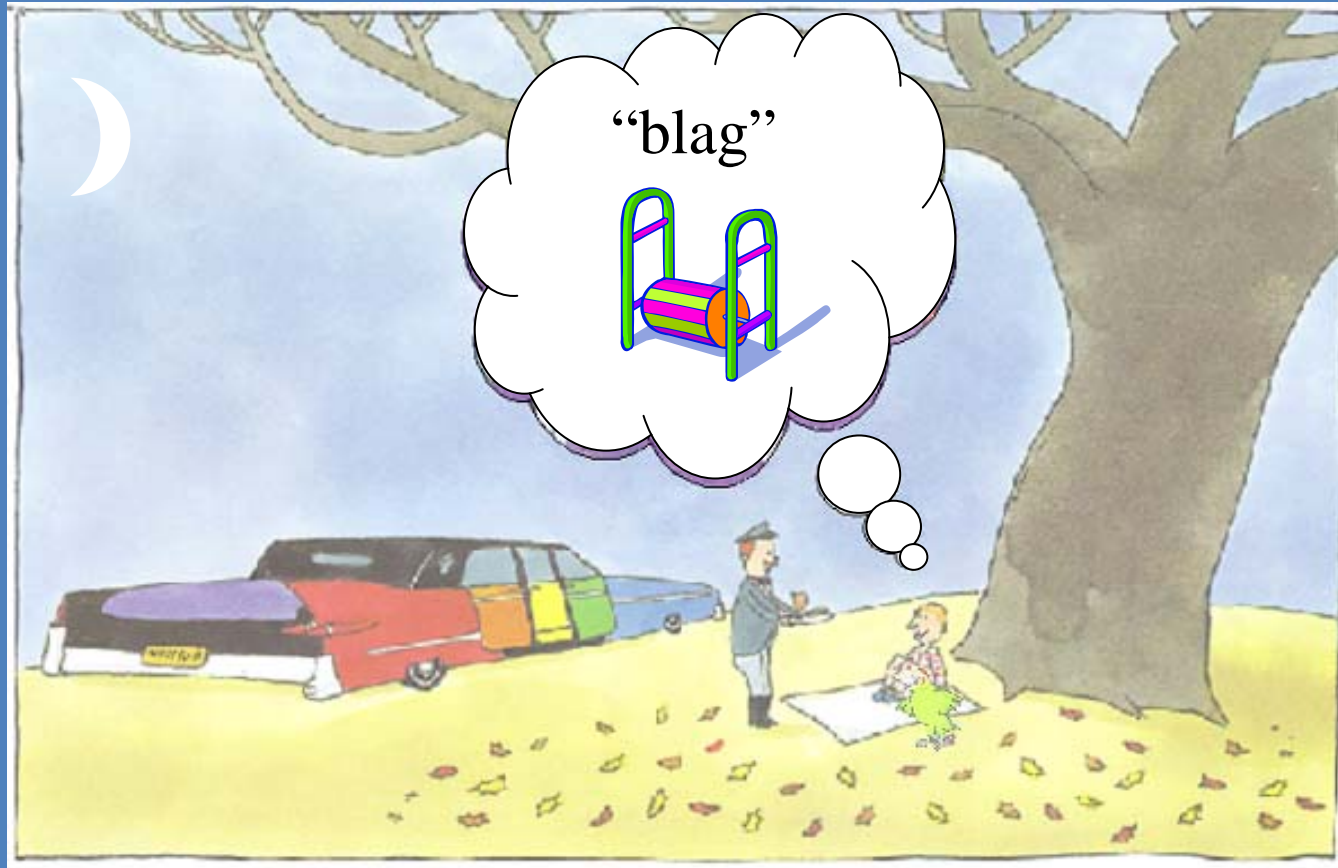


# Does HF information impact other areas of communication?

- Learning New Words
  - Critical accomplishment of childhood
    - Speak effectively
    - Read comprehensively
    - Write meaningfully
  - Children with hearing loss have smaller vocabularies
    - Average 2-3 year delay
    - Delay is related to degree of hearing loss

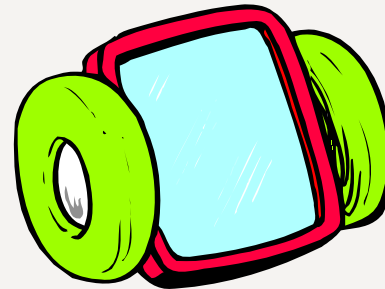
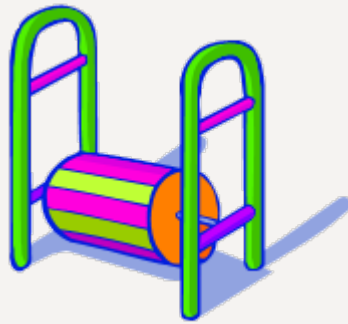


# Rapid word-learning in NH and HI children... (Pittman et al, 2005)

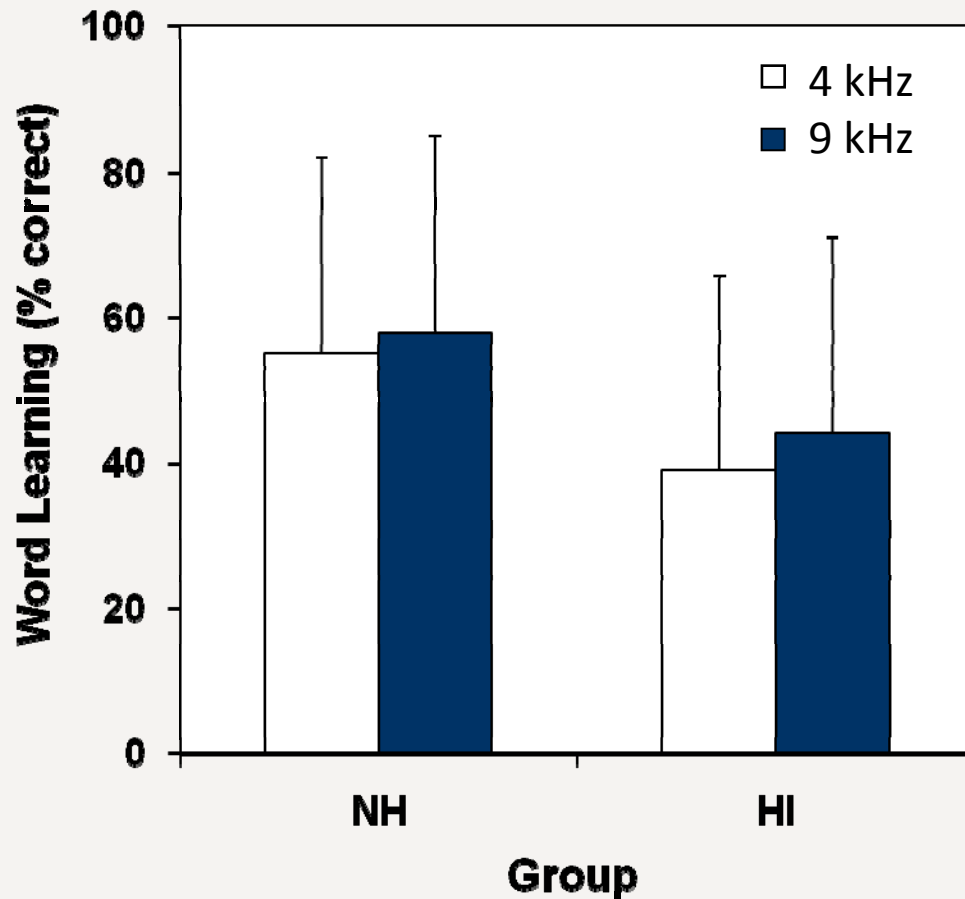


# Rapid word-learning in NH and HI children... (Pittman et al, 2005)

“Which one is the blag?”

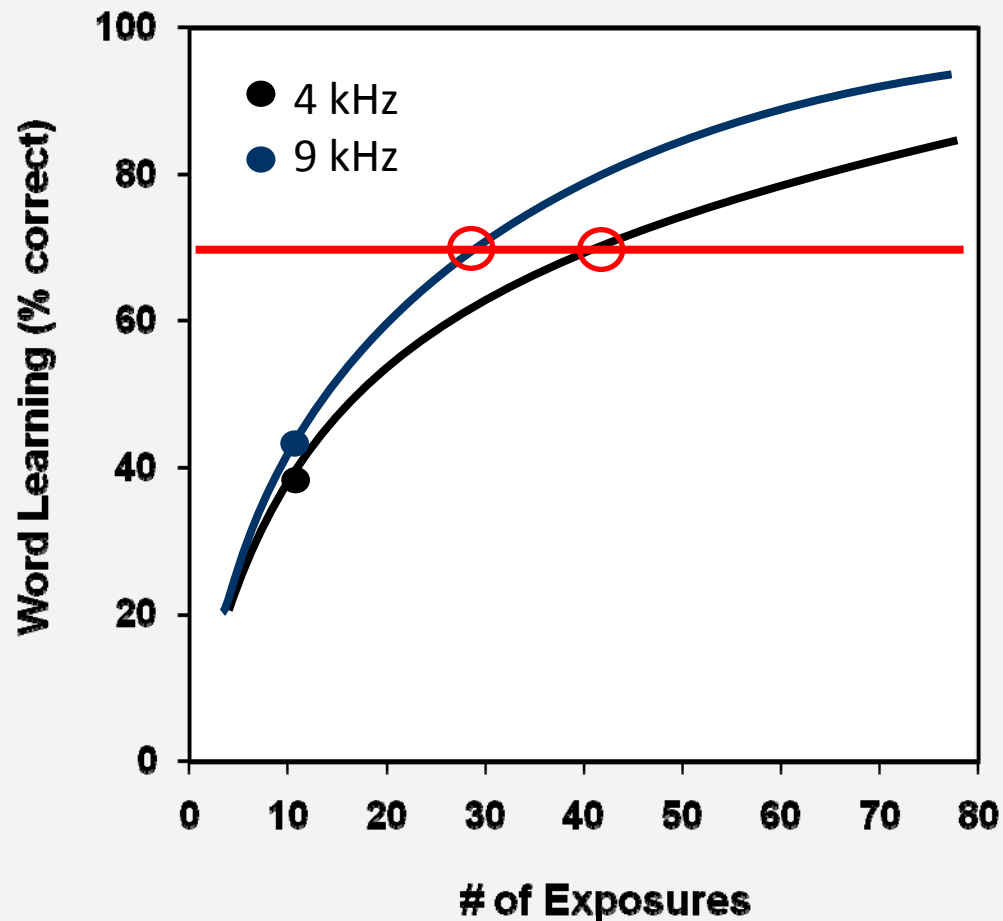


# Rapid word-learning in NH and HI children... (Pittman et al, 2005)



Pittman et al (2005)

# Short-term word-learning rate in children... (Pittman, 2008)





# Method: Participants

- 8- to 10-year-old children
  - 36 with NH
  - 14 with HL
    - Bilateral, moderate sensorineural hearing loss

4kHz



9kHz





# Method: Novel-Words

4 kHz

9 kHz

s a θ n ə d

sothnud



d a z t ə l

doztul



f a s n ə ʃ

fosnush



s t a m ə n

stomun



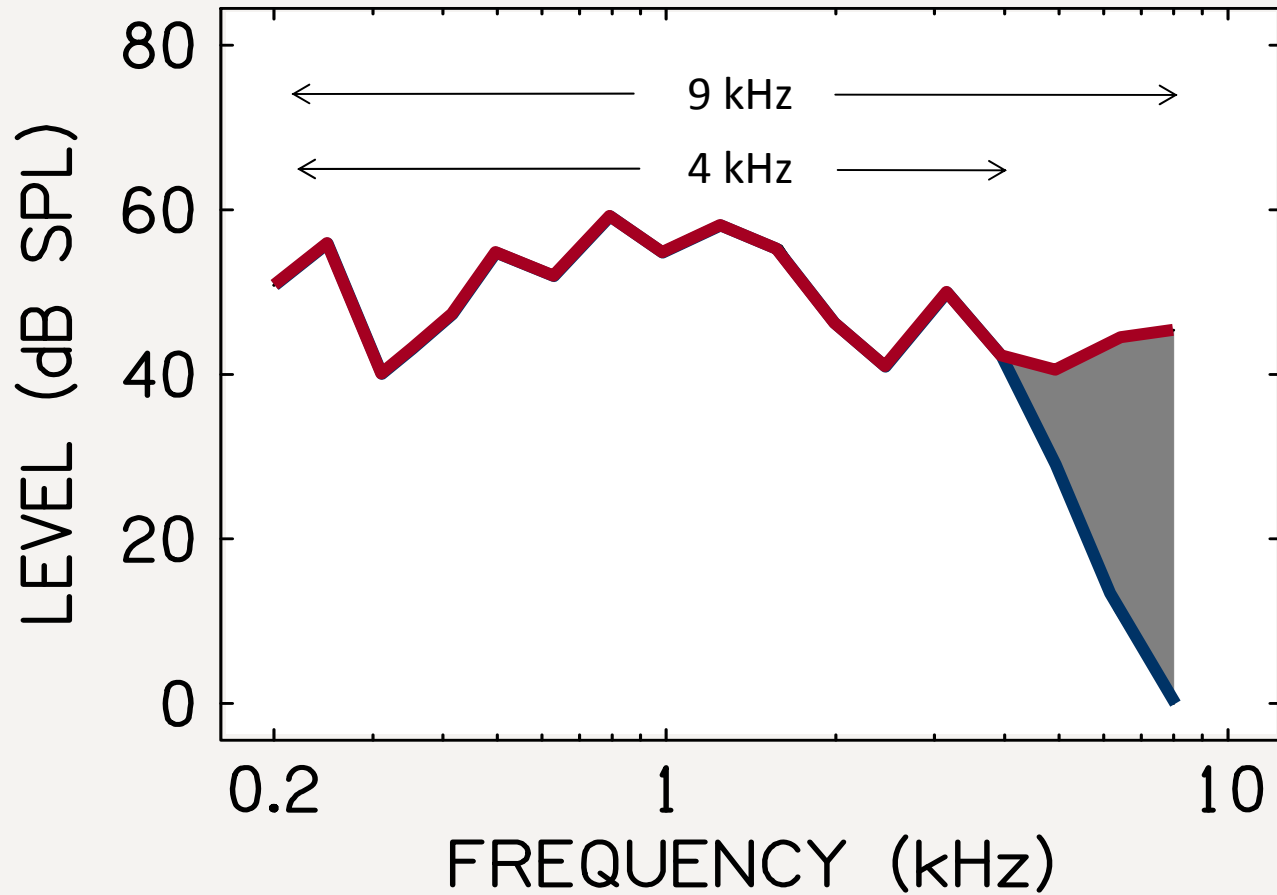
h a m t ə l

homtul



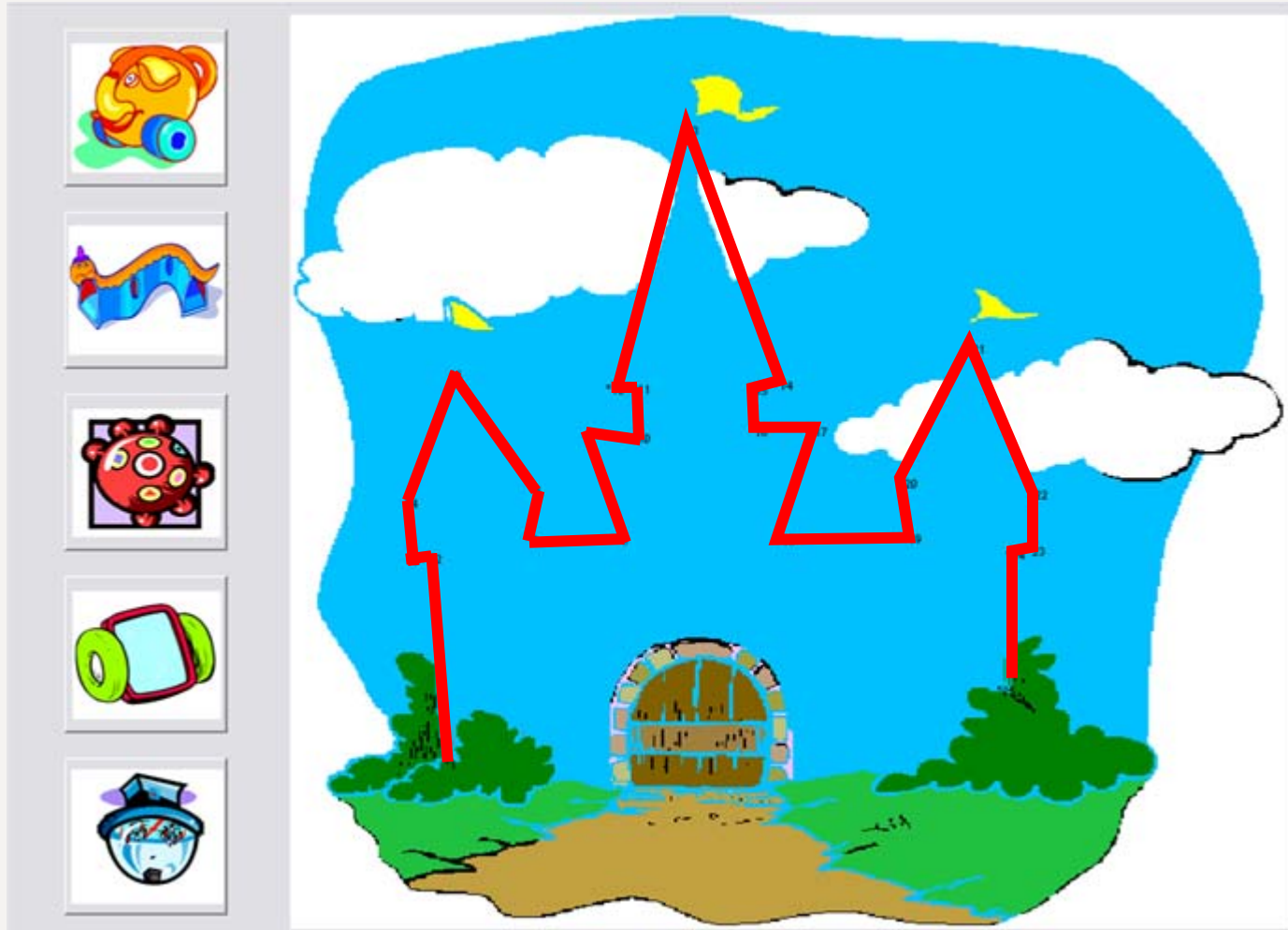


# Method: Novel-Words



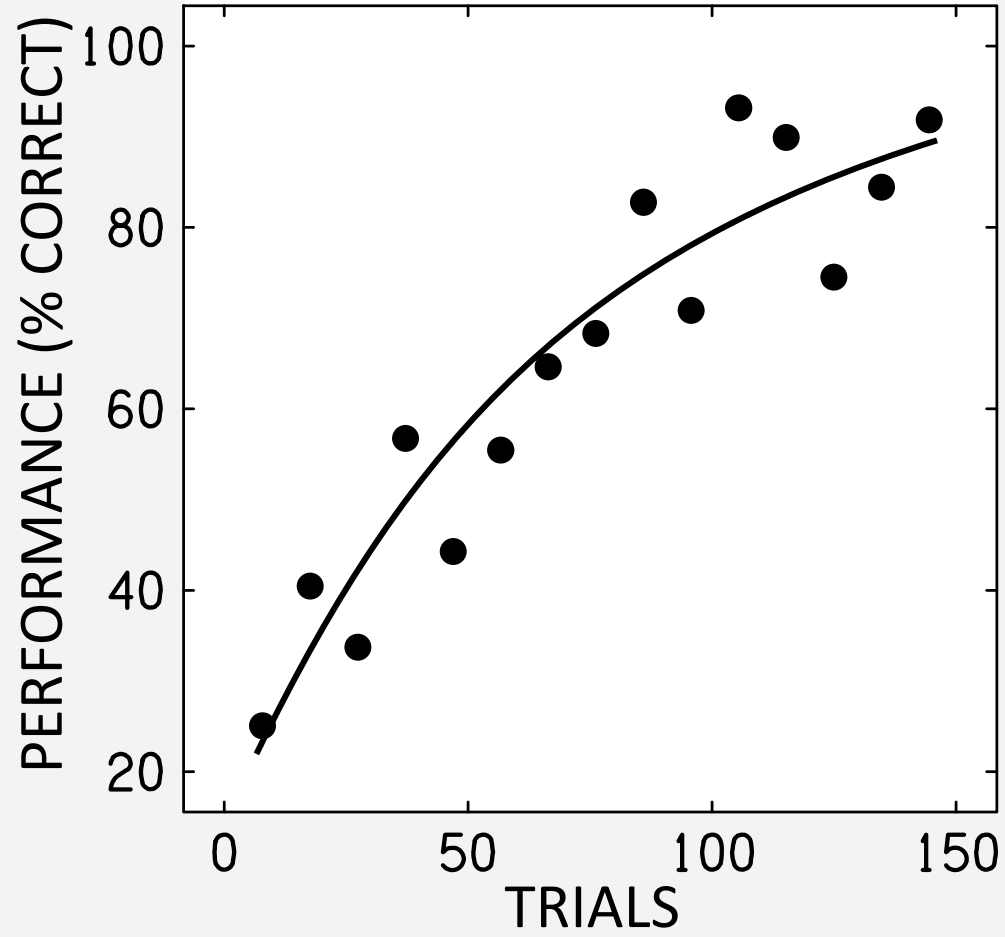


# Method: Learning Game

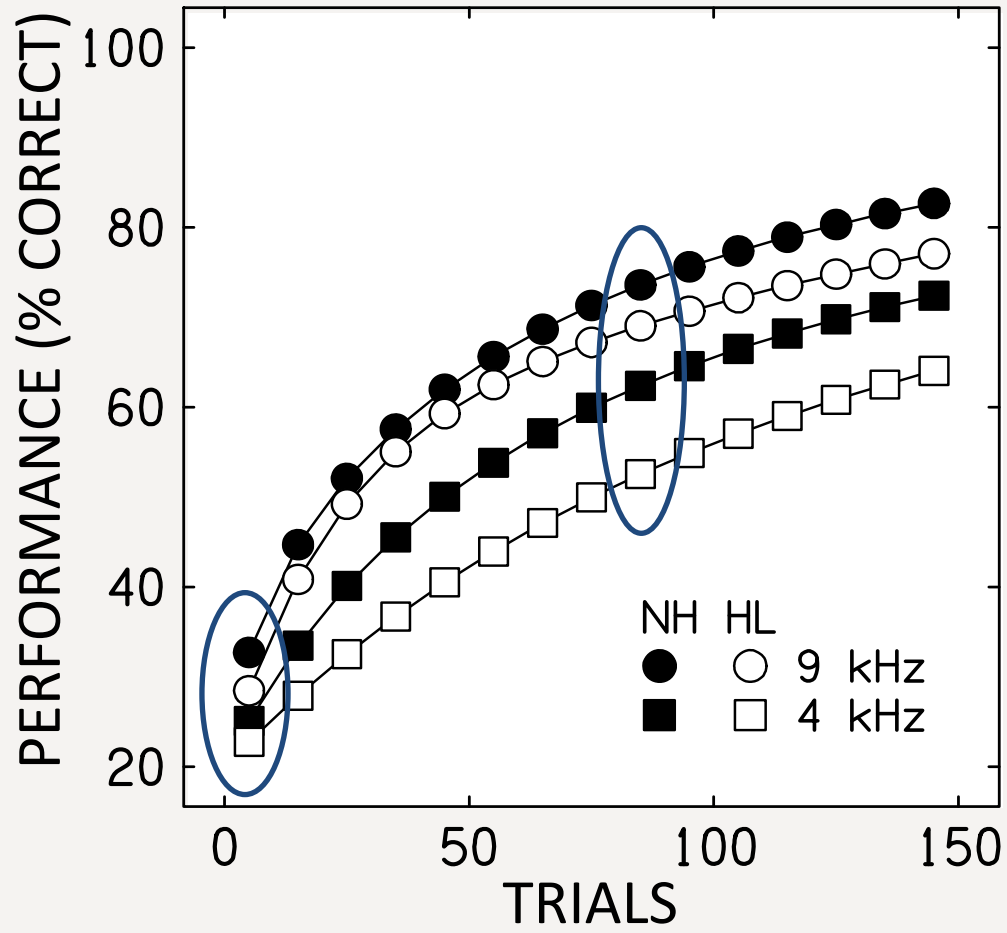




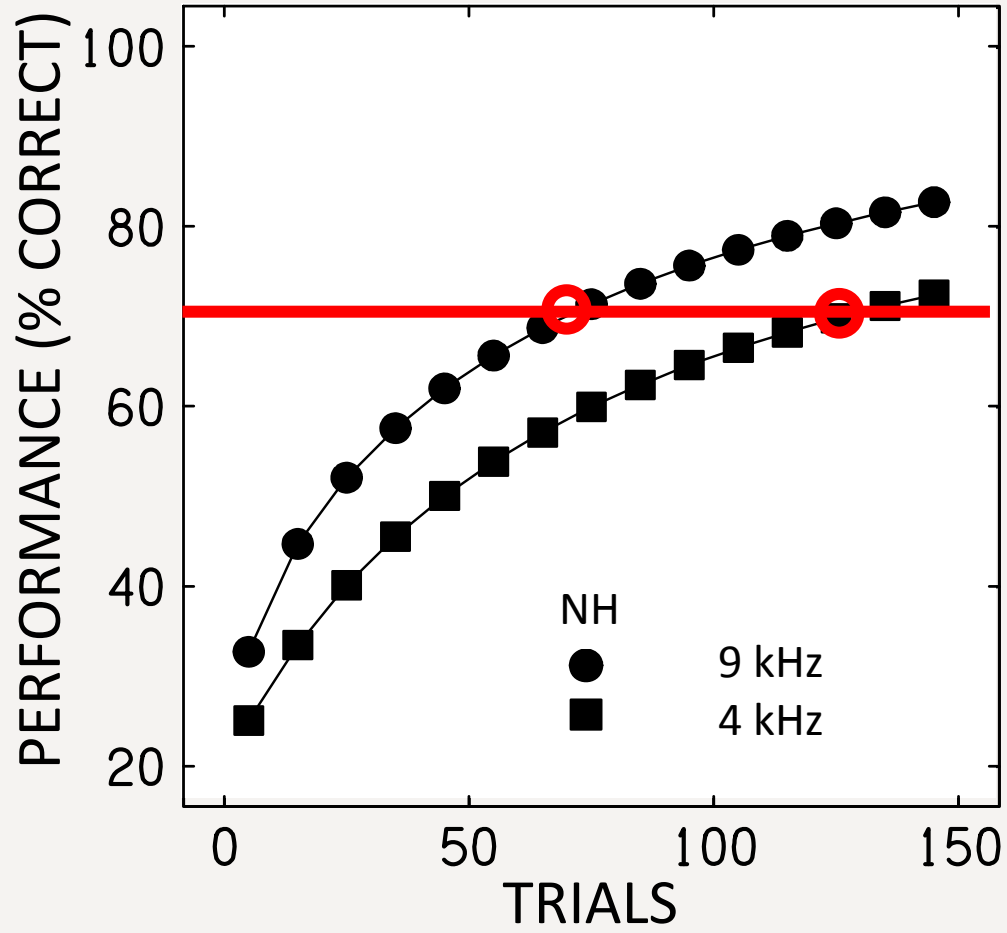
# Method: Analysis



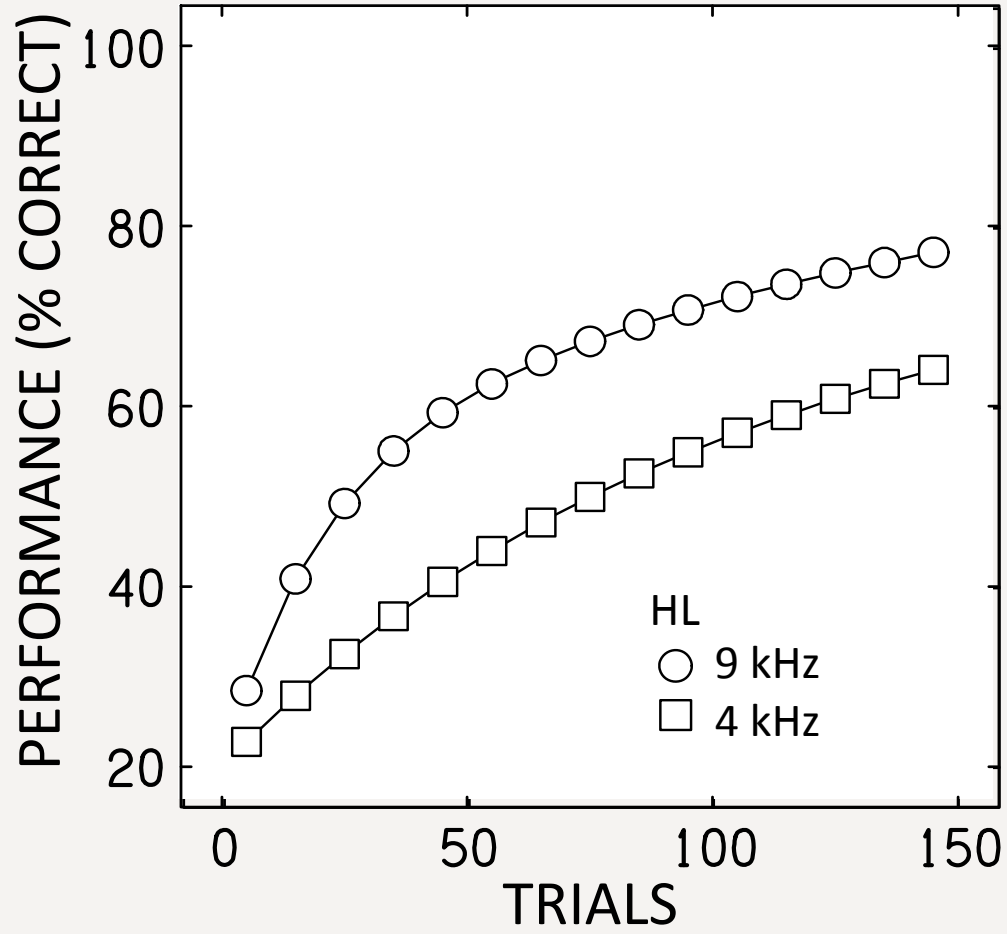
# Results



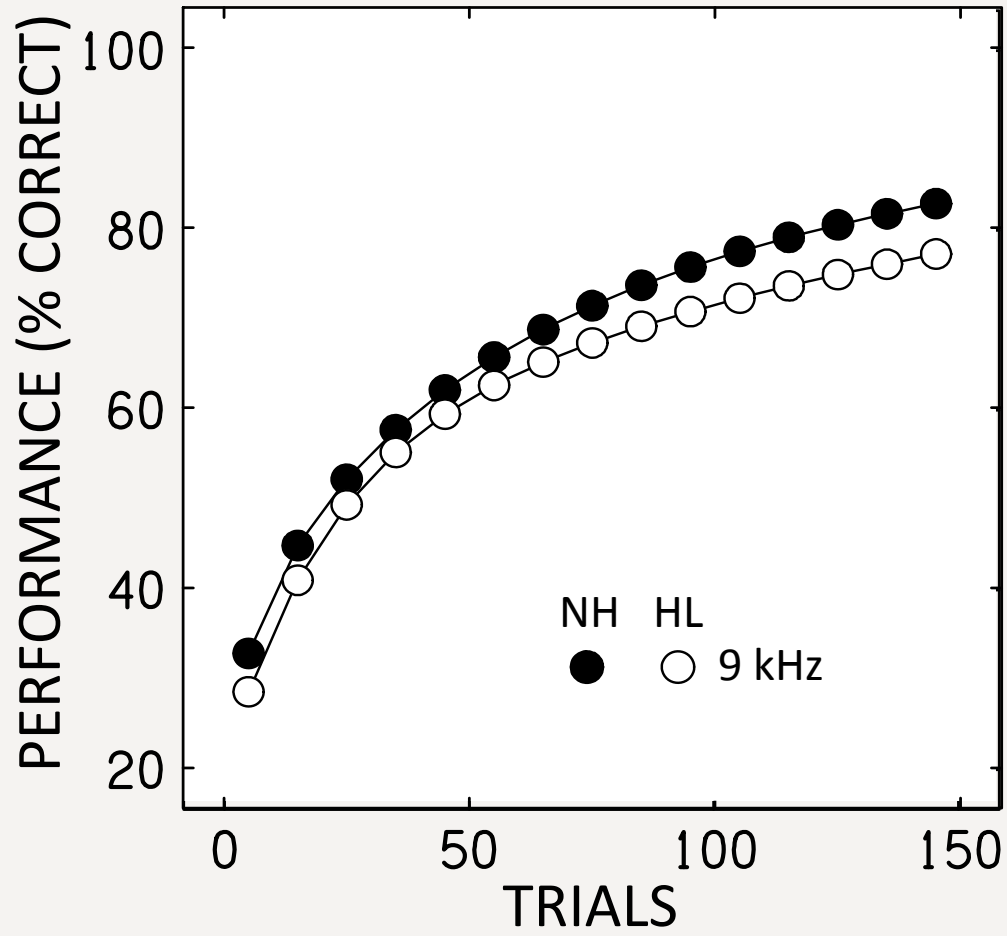
# Results



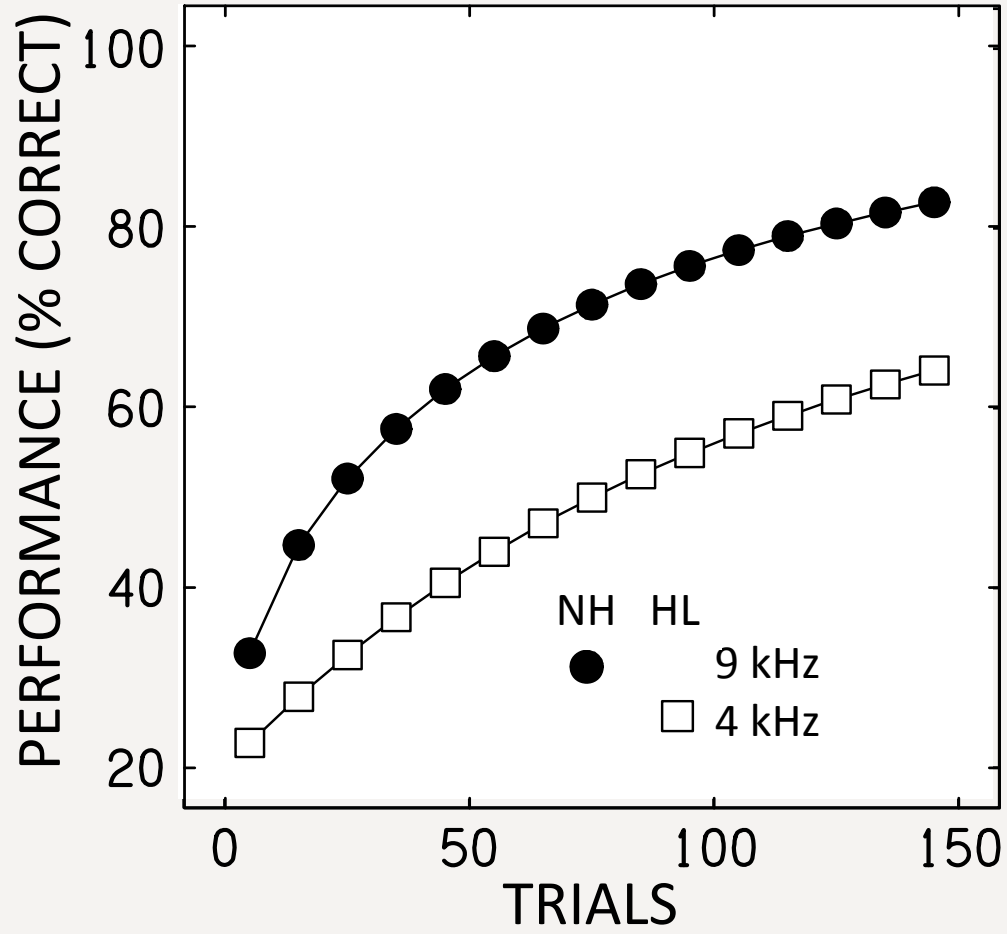
# Results



# Results



# Results



# Summary

- High-frequency information effects
  - Fricative production
  - Morpheme use
  - Fricative perception
  - Word-learning rate





# Summary

A wearable device is needed to examine further the short- and long-term effects of high-frequency amplification



ThE End

