

Should digital noise reduction be activated in pediatric hearing-aid fittings?

Ryan McCreery, ABD CCC-A

Research Audiologist

Boys Town National Research Hospital

Omaha, Nebraska, USA

Supported by NIDCD -F31-DC010505-01A1 R01-DC004300-11 P30-DC004662-10 T35-DC008757-04

Boys Town National Research Hospital

Omaha, Nebraska



Objectives

- What is digital noise reduction (DNR)?
- Should DNR be implemented with infants and children?
- If so, how can DNR be verified?



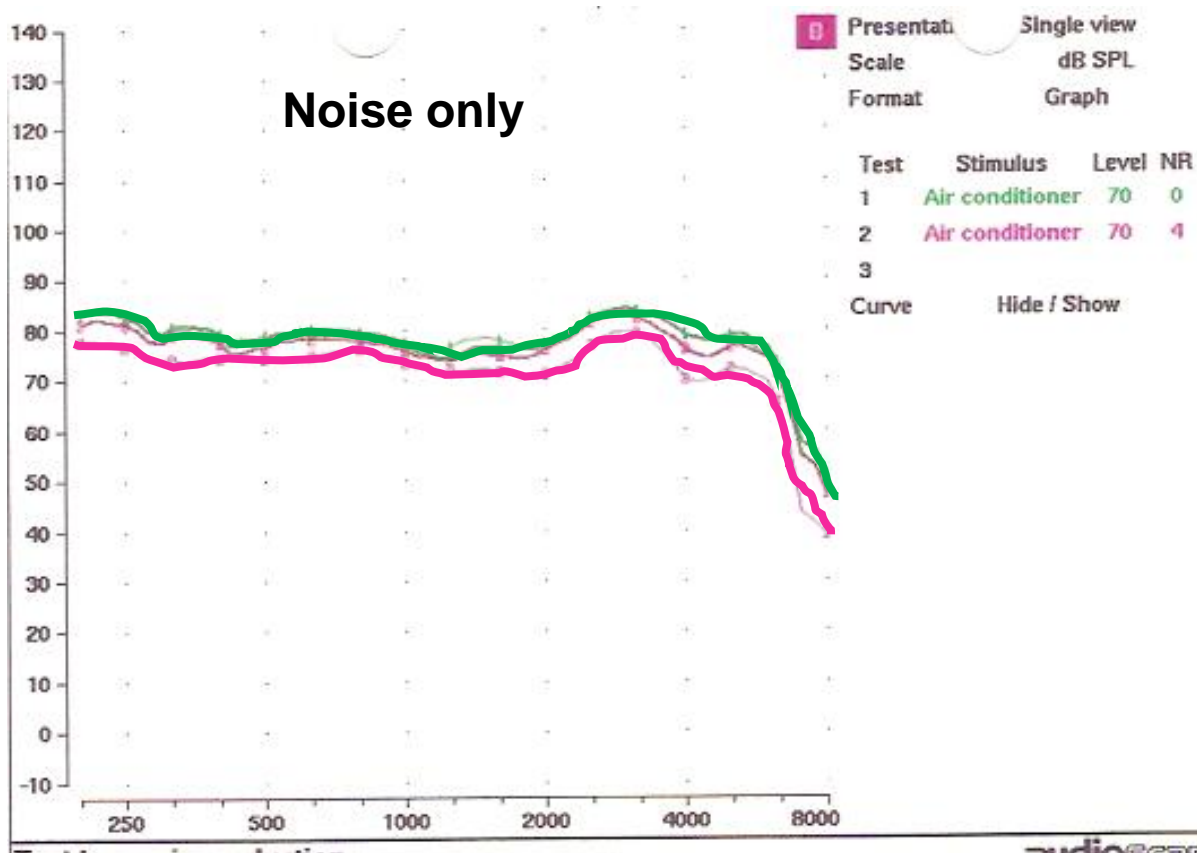
Noise



Digital noise reduction (DNR)

- Hearing aid signal processing strategy designed to limit the negative consequences of background noise
 - Achieved through reduction of gain

Example of DNR

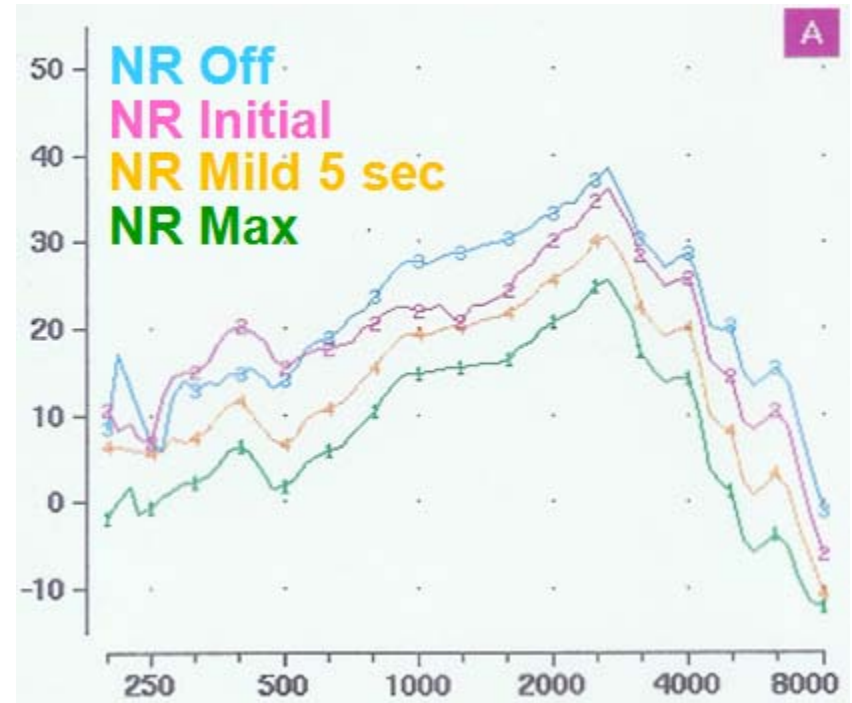


DNR Off

DNR On

DNR is complex

- Method of DNR varies widely:
 - Device/manufacturer
 - Frequency
 - Activating signal
 - Input level
 - Audiometric thresholds
 - Amount of gain reduction
 - Time constants



DNR Studies with Adults

- Speech recognition is not improved or degraded with DNR
- Adult listeners report:
 - Preference for DNR
 - Improved listening comfort
 - Higher acceptable noise level (ANL)
- See Bentler & Chiou 2006 for review

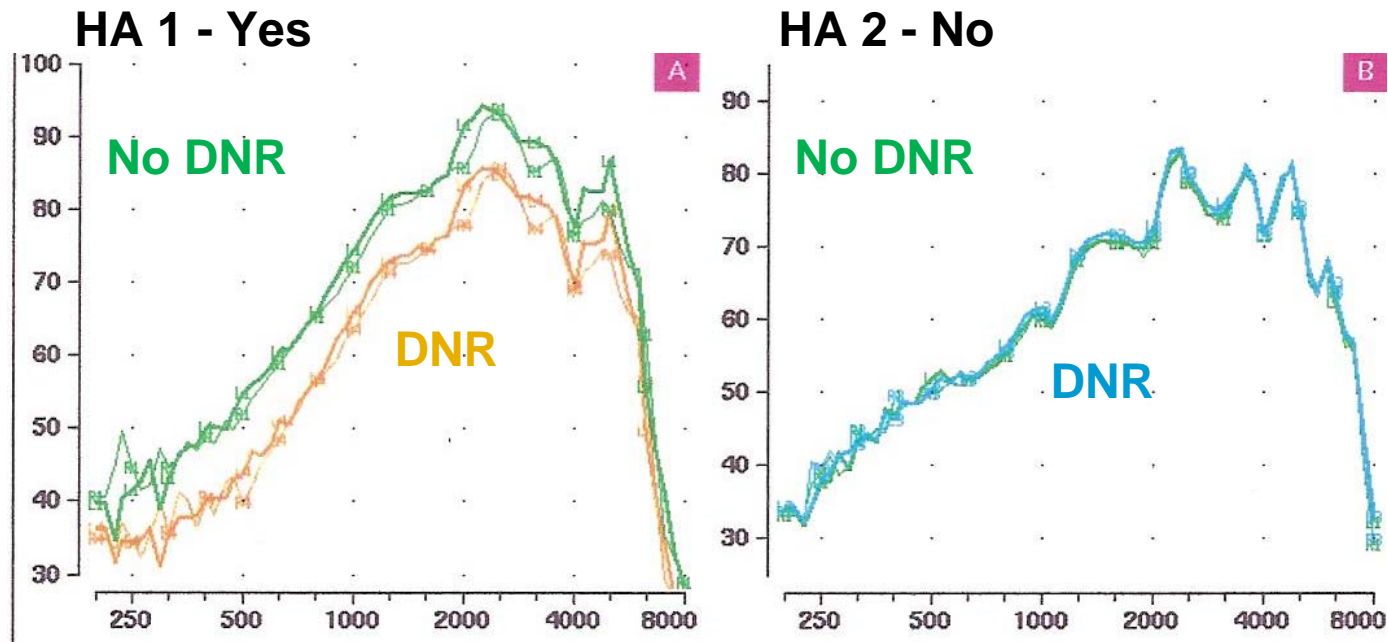


What about infants and children?

- Children require greater audibility
- Children experience greater degradation of speech understanding in noise
- Comfort and ease of listening are still important



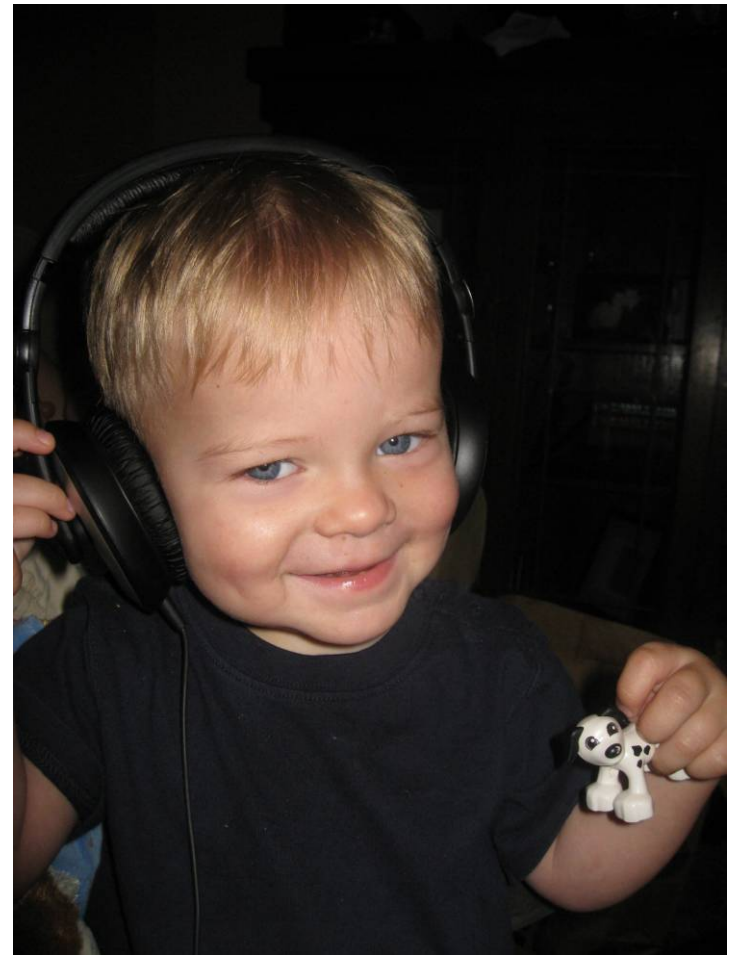
Does DNR reduce gain for speech?



Speech + Steady-state noise (+3 SNR)
Same audiogram

BTNRH DNR studies with children

- Stelmachowicz et al. 2010
- Gustafson et al. 2010



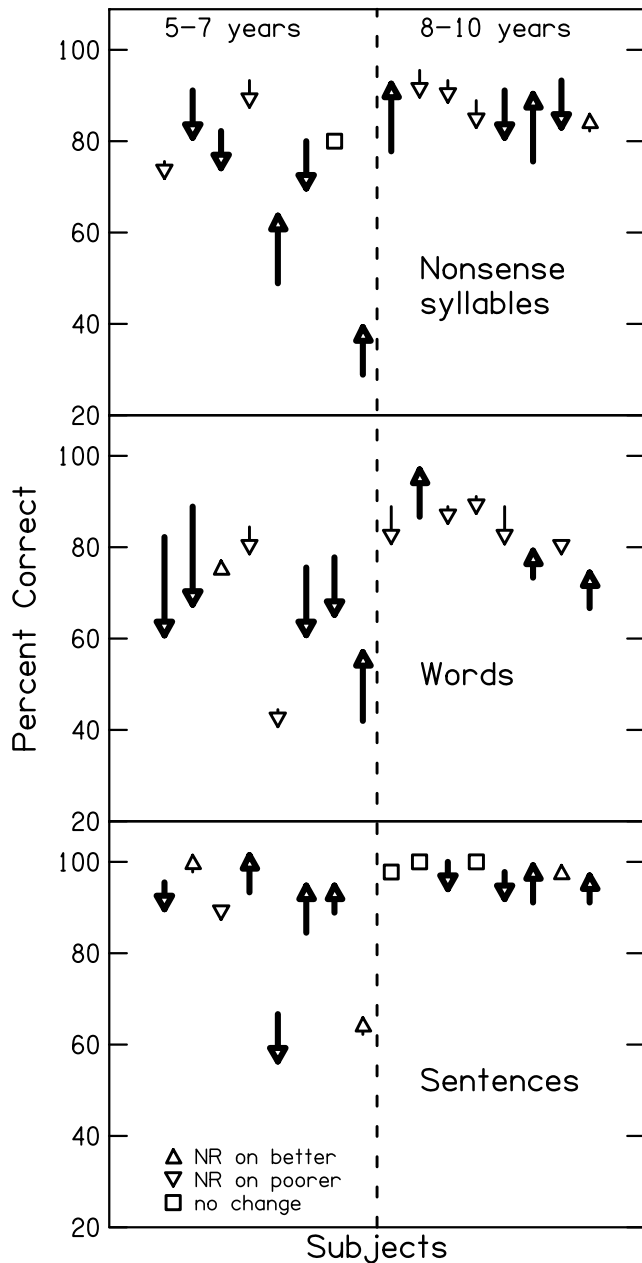
Stelmachowicz et al. 2010

- 16 children with hearing loss
 - 5 – 10 years
- Speech recognition:
 - VCV syllables (/asa/)
 - Monosyllabic words (PBK)
 - Sentences (BKB)
- Speech-shaped noise
- DNR on/off



Results

- On average, no significant improvement or degradation of speech recognition with DNR
 - No interaction for:
 - Nonsense syllables, words or sentences (stimulus)
 - Signal-to-noise ratio



Significant individual variability

Performance was less variable for older children

Sentences > Nonsense > Monosyllables

Some significant individual decreases with DNR – none across all three stimulus types for same subject

Stelmachowicz et al. 2010

Limitations

- One algorithm
- Included only mild to moderate loss
- Some children near ceiling for DNR off condition
 - Sentences
- No quantification of DNR effect



Gustafson et al. 2010

- How does DNR influence:
 - Speech recognition
 - Listening effort
- Normal-hearing children
 - 7 -12 years-old
- Two DNR algorithms
- Results presented as poster at this meeting

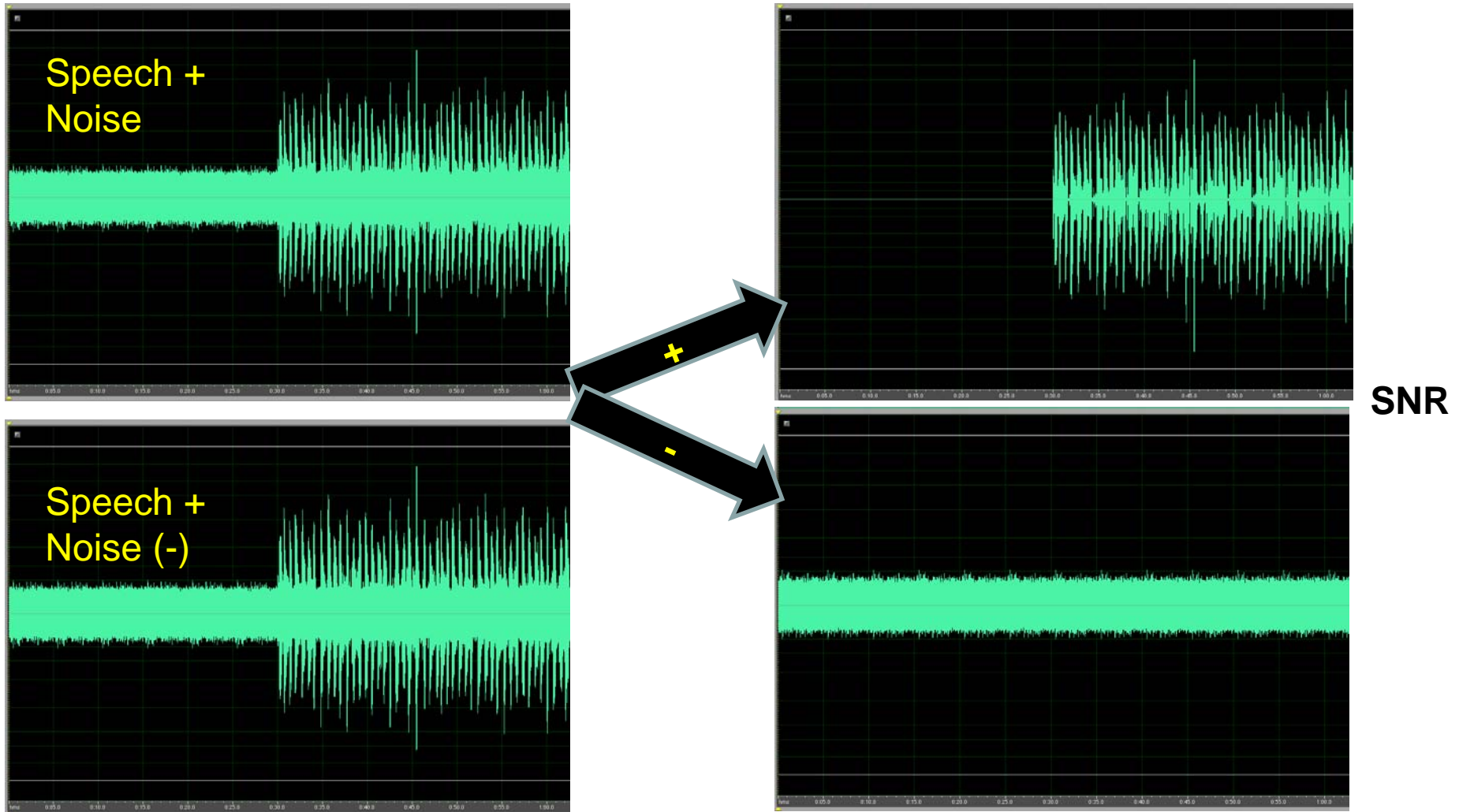


Gustafson et al. Methods

- Quantification of DNR
 - Inversion method (Hagerman & Olofssen, 2004)
 - Coherence (Lewis et al. 2009)
- Limit ceiling effects
 - CVC nonword stimuli



Inversion Method



Results from Gustafson et al.

- Speech recognition
 - Improved by DNR algorithm that improved SNR with inversion
 - No change with algorithm that maintained SNR
- Verbal response time
 - Improved for both DNR algorithms



Summary of Pediatric Studies

- DNR does not degrade speech recognition for children ages 5-12
- DNR may improve ease of listening for normal hearing children
 - Not dependent on improving speech recognition



Limitations of current studies

- Results needed for
 - Additional algorithms
 - Greater degrees of loss
 - Younger children
 - Real world environments / outcomes

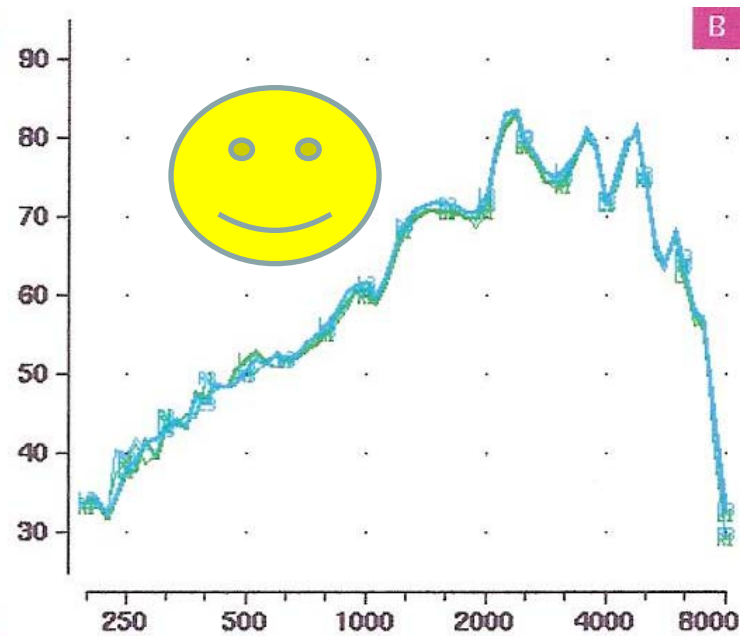
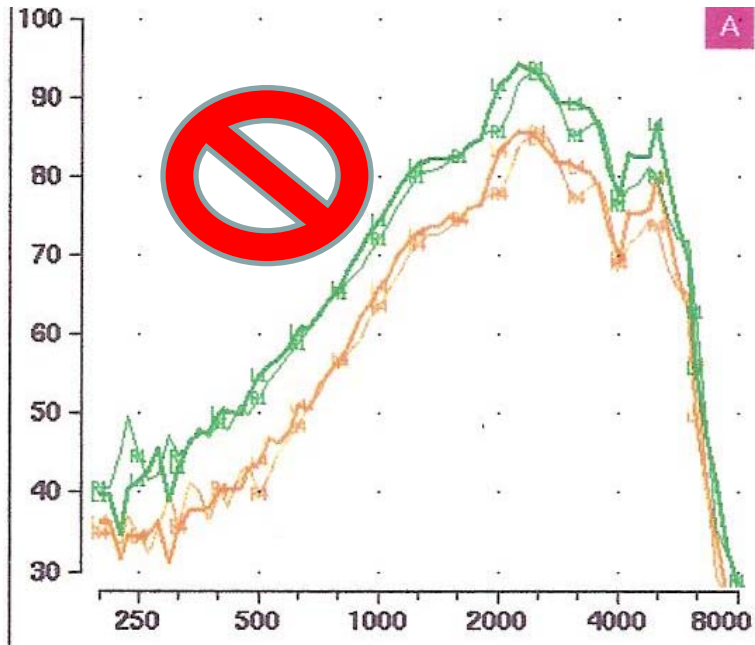


Should we use DNR with children?

- Emerging evidence for school-age children
- Limited evidence for infants and younger children
- Verification of effects on speech with noise must occur

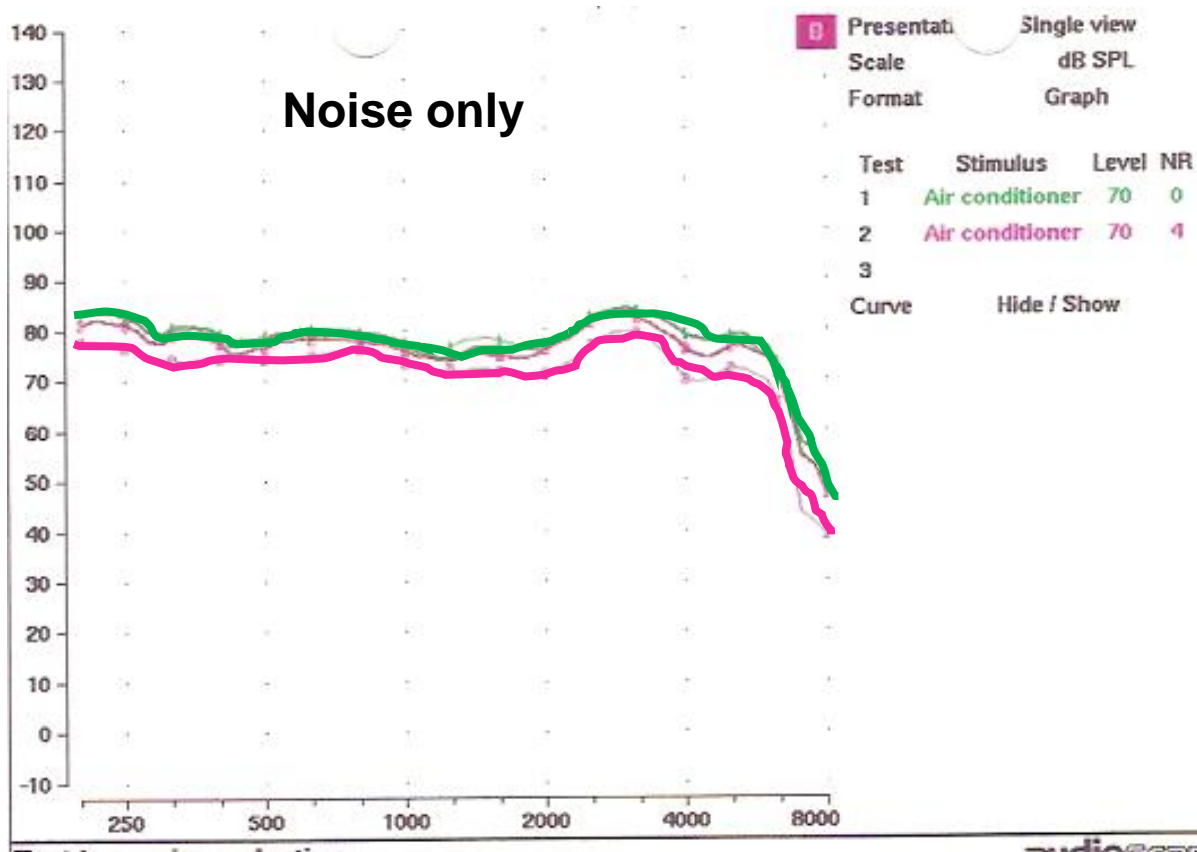


Verification of DNR



Verifit directional test mode
Fixed omnidirectional setting
65 dB input level
+3 SNR

Effects with noise only



DNR Off

DNR On

Steady-state
noise with
non-Verifit
system



Clinical recommendations

- Evaluate DNR algorithms individually
 - Determine effect on speech + noise
- Select algorithms for children that maintain speech signal
- DNR is not our only (or even best) tool!
 - FM systems
 - Directional microphone
- Counsel families about reducing noise

Acknowledgements

- Hearing and Amplification Research Lab
 - Pat Stelmachowicz
 - Dawna Lewis
 - Judy Kopun
 - Brenda Hoover
 - Jody Spalding
 - Kanae Nishi
- Arizona State University
 - Samantha Gustafson

Supported by NIDCD F31-DC010505-01A1
R01-DC004300-11 P30-DC004662-10
T35-DC008757-04

Questions / Comments?