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

Noise only

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?

HA 1 - Yes

No DNR
DNR

HA 2 - No

No DNR
DNR

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
• 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

Hagerman & Olofsson, 2004
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

Noise only

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?