Hearing Aid Features & Tier Levels Examined Within & Beyond the Clinical Setting

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Audiology and Speech Pathology

Presentation Overview

- Part I: Hearing Aid Features
  1. Frequency Compression, Noise Reduction
  2. Extended Input Dynamic Range

- Part II: Hearing Aid Tier Levels
  3. Adaptive Program Switching
  4. Noise Management Features
  5. Hearing Aid Fittings

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Frequency Compression & Noise Reduction

The Effects of Non-Linear Frequency Compression and Digital Noise Reduction on Word Recognition and Satisfaction Ratings in Noise in Adult Hearing Aid Users

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Background

- Non-Linear Frequency Compression (NLFC)
  - Often used in adult fittings & studied extensively in isolation
  - Moves high frequency energy into lower frequency regions
  - Compresses frequencies above a cut-off frequency
    - shifts them to a lower frequency range
    - according to the frequency compression ratio
  - Attempts to improve the audibility of high frequency speech cues otherwise unaidable

Background

- Digital Noise Reduction (DNR)
  - Often used in adult fittings & studied extensively in isolation
  - Attempts to improve the signal-to-noise ratio of the hearing aid
  - Analyzes incoming signals and alters the gain and output on the basis that:
    - speech is a highly modulated signal
    - background noise is less modulated
  - Goal is to improve speech perception and listening comfort in background noise

Background

- NLFC Research
  - Used various outcome measures
    - Sound detection
    - Consonant recognition
    - Word recognition
    - Plural recognition
    - Speech recognition in noise
    - Self-report
  - Outcomes varied in quiet and in noise

Background

- NLFC in Quiet
  - Improved
    - consonant recognition, plural recognition, monosyllabic word recognition, speech recognition thresholds, and vowel-consonant stimuli processed with NLFC
  - No effect
    - consonant recognition, dual-task cognitively loaded tests of speech intelligibility, consonant discrimination, or monosyllabic word recognition

Background

- NLFC in Noise
  - Improved
    - sentence recognition
    - consonant recognition
  - No effect
    - QuickSIN
    - Modified Rhyme Test
    - Dual-task cognitively loaded tests of speech intelligibility

Background

- NLFC Self-Report
  - No significant preference for NLFC on or off in quiet or noise
  - One study suggested satisfaction improved after two months of NLFC use
- NLFC Benefit
  - May be related to the degree and configuration of the hearing loss and the age of the hearing aid user
    - listeners with more high frequency hearing loss receive more benefit from NLFC than listeners with less high frequency hearing loss
    - individuals with similar degrees and configurations of hearing loss did not show significant benefit with NLFC
    - hearing aid users over the age of sixty-five received more benefit from NLFC

Background

- NLFC Summary
  - Research suggests benefit with NLFC in quiet and in noise varies significantly
  - Benefit variability with NLFC may be related to factors such as:
    - type of outcome measures used
    - variability in NLFC fitting protocols
    - degree of hearing loss, configuration of hearing loss, and the age of the hearing aid user

Background

- DNR Research
  - As with NLFC, multiple studies have evaluated DNR in isolation
    - DNR did not improve speech intelligibility or satisfaction in adults
    - DNR improved listening comfort and preference
      - did not improve speech understanding in noise
    - Speech perception measures and sound quality ratings
      - no effect of NR on versus off
      - differences were seen amongst NR on-set times
        - » 4-second onset time rated poorer than the 8-second onset

Background

- DNR Research
  - DNR improved self-reported listening effort in challenging listening environments
  - DNR improved acceptance of noise
- DNR Summary
  - No effect on speech understanding
  - Improved listening comfort, effort, and noise acceptance

Background

- Isolation
  - NLFC: results vary in quiet and in noise
    - Outcome measures, protocols, patient factors
  - DNR: no impact on speech recognition yet improved listening comfort
- Simultaneous
  - Previous research evaluated each feature in isolation
  - NLFC and DNR are commonly used simultaneously in adult hearing aid fittings.
    - Does simultaneous use of NLFC and DNR affect listener performance?

Hypothesis & Rationale

- Hypothesis 1
  - The combined use of DNR with NLFC will improve performance in noise
- Rationale 1
  - NLFC improves the audibility of high frequency speech sounds
  - DNR decreases background noise
  - Used together:
    - improved speech intelligibility (NLFC)
    - improved comfort and effort (DNR)

Hypothesis & Rationale

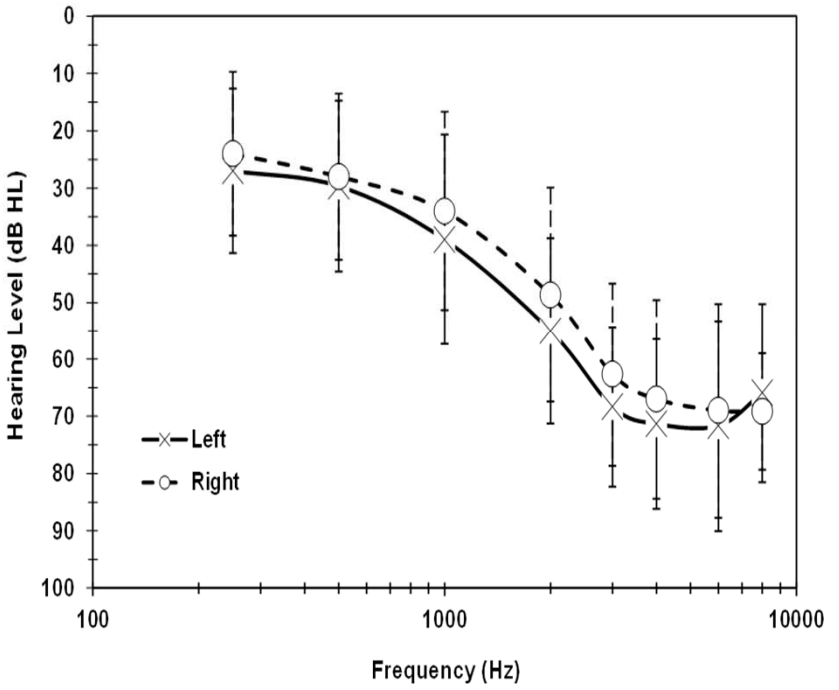
- Hypothesis 2
  - The combined use of DNR with NLFC will degrade performance in noise
- Rationale 2
  - Many speech sounds NLFC targets have modulation patterns consistent with noise
    - such as fricatives, affricates, and sibilants
  - The increased high frequency audibility from NLFC could be offset by gain reduction from DNR
    - thereby reducing speech intelligibility and sound quality in noise

Purpose

- To evaluate the effects of NLFC and DNR on listener performance in noise in adults
- Research Questions:
  1. Does the isolated or combined use of NLFC and DNR improve word recognition in noise?
  2. Does the isolated or combined use of NLFC and DNR improve satisfaction ratings in noise?

Methods

- Participants
  - 15 current Phonak Bolero users
    - 13 used FC
    - All used NR
  - Mean 73 years of age
    - 55 – 83 year range
  - Sensorineural loss



Methods

- Hearing Aids
  - Phonak Bolero Q-90 P devices
    - Same two aids for all participants
    - Slimtube and dome coupling used mimicked each participant's current setup
    - Adaptive feedback cancellation was deactivated to maximize high-frequency amplification (2 exceptions)
    - Omnidirectional microphone mode
      - to assess the effects of DNR without influence from a directional microphone
    - DNR was activated at the maximum setting for each device

Methods

❖ Hearing Aids

- Experience level was set to 100%
- Hearing aids were programmed with four conditions in random order:

Program	Frequency Compression	Noise Reduction
Baseline	OFF	OFF
Frequency Compression	ON	OFF
Noise Reduction	OFF	ON
Combined	ON	ON

Methods

- Hearing Aid Fittings
  - Desired Sensation Level v5.0 (adult) fitting strategy
    - maximize high-frequency audibility
  - Verification:
    - Audioscan Verifit Open fittings (speech at 65 dB SPL)
    - NLFC & DNR were deactivated initially
    - Match targets using a criteria of +/- 6 dB from 500 to 4000 Hz

Methods

- Hearing Aids & Fittings
  - NLFC Verification
    - Calibrated /s/ and /ʃ/ stimuli of 65 dB SPL
    - DNR was deactivated to prevent interaction with the /s/ or /ʃ/ stimuli
    - Assess the audibility and spectral separation of the /s/ and /ʃ/ stimuli
    - NLFC adjusted to the weakest possible settings that provided audibility and spectral separation of the two sounds
    - Following NLFC verification, DNR was activated in the DNR and Combined programs

Methods

- Stimuli
  - Modified Pascoe's High-Frequency Word List (HFWL)
    - Pascoe's HFWL consists of four lists of 50 monosyllabic words
    - 25 monosyllabic words containing affricates, fricatives, and/or sibilants were used
      - words containing high-frequency information with noise-like modulation patterns would be more sensitive to the effects of NLFC and DNR
    - the same 25 words were randomized into four lists

Methods

- Stimuli
  - Speech spectrum noise (GSI-61)
    - NR is more effective for steady-state noise than noise containing speech
  - Pilot testing with a KEMAR:
    - DNR engaged after 16 seconds of noise
      - 30 seconds of noise preceded the presentation of the speech
      - ensured DNR was activate
      - noise was constant during testing
    - speech presented after 30 seconds of noise engaged the NLFC and DNR of the test hearing aids

Methods

- Protocol
  - Speech and noise stimuli
    - loudspeaker located at zero degrees azimuth in the sound booth
    - one meter from the participant
    - speech stimuli were always 65 dB SPL
    - noise was either 64 dB SPL or 59 dB SPL
      - 1 or 6 dB signal-to-noise ratio (SNR)
      - SNRs were chosen so findings could be directly compared to previous DNR research

Methods

- Protocol
  - Word recognition
    - Assessed in each hearing aid and SNR condition
      - Hearing Aid condition
        - » Baseline, NLFC, DNR, and Combined
      - SNR
        - » 1 dB and 6 dB
    - Hearing aid condition, SNR, and word list order were randomly assigned for each participant

Methods

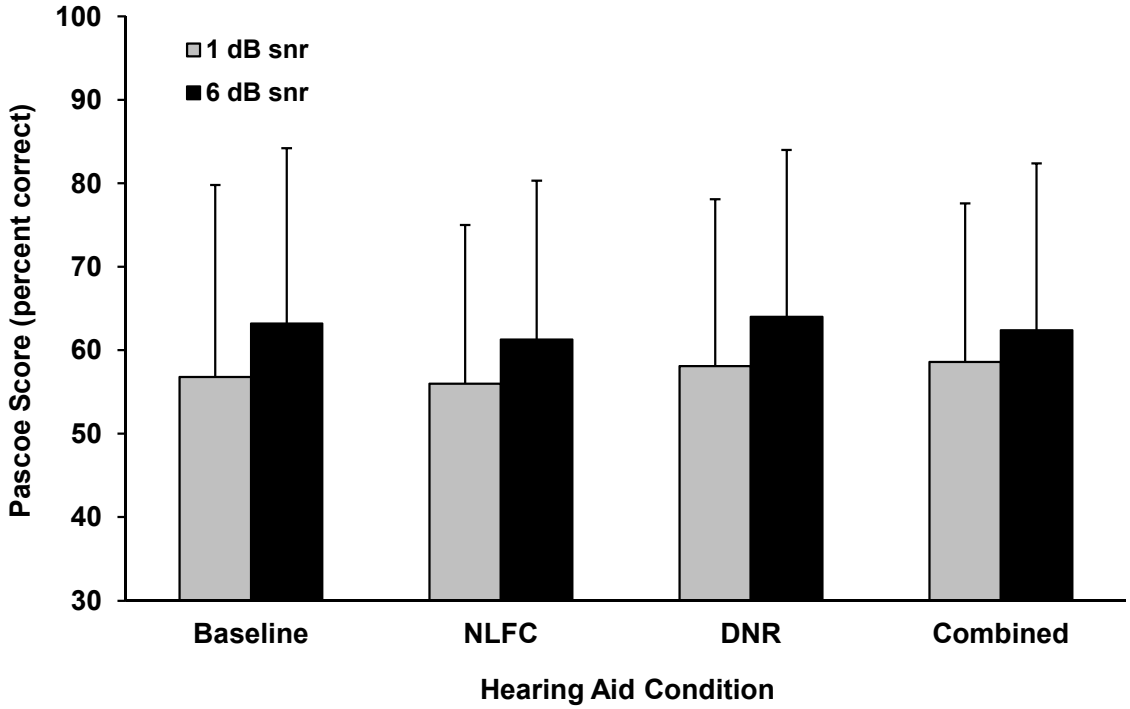
- Protocol
  - Satisfaction-participants rated their satisfaction with word clarity and comfort

Word Clarity	Word Comfort
5 Very Clear	5 Very Comfortable
4 Somewhat Clear	4 Somewhat Comfortable
3 Clear	3 Comfortable
2 Unclear	2 Uncomfortable
1 Very Unclear	1 Very Uncomfortable

Methods

- Instructions
  - *"At the end of the 25 word list, you will be asked to rate how satisfied you were with the clarity and the comfort of the words using the scales posted on the wall in front of you."*
- Scoring
  - Half ratings between intervals were allowed (ex. 1.5 or 3.5).
  - Average satisfaction was calculated by averaging the clarity and comfort ratings

Results—Word Recognition



No Hearing Aid effect

Significant SNR effect

1 dB < 6 dB

No Interaction

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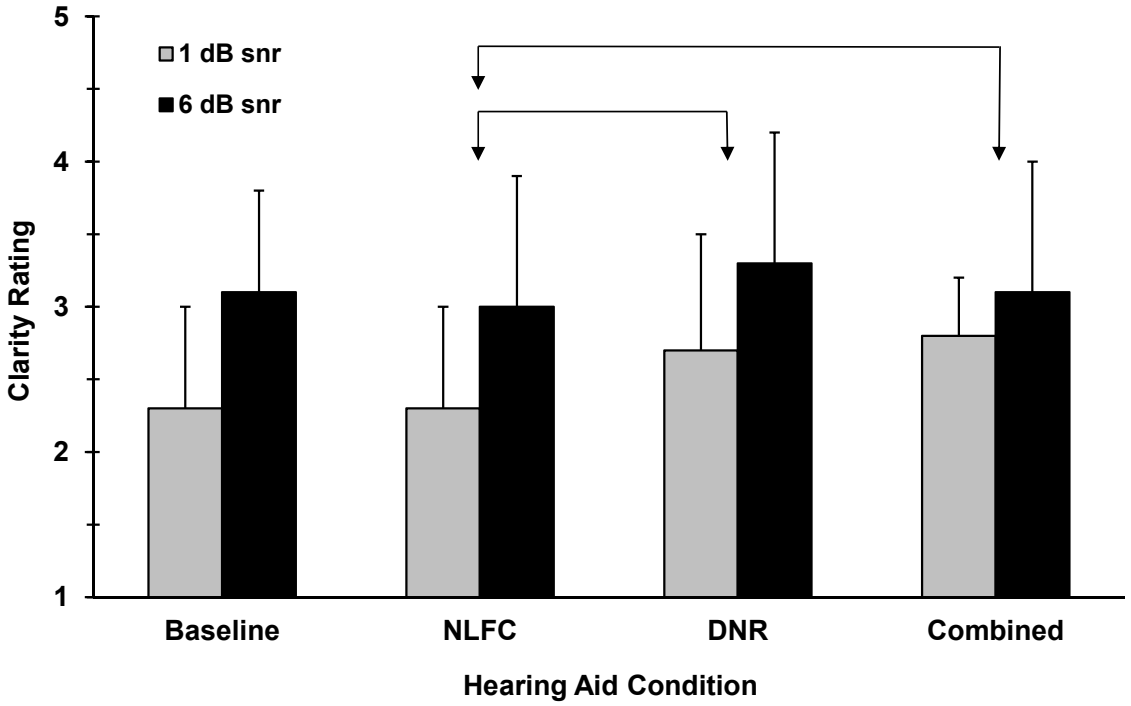
Results—Clarity Rating



Significant Hearing Aid effect

NLFC < DNR & Combined

Significant SNR effect

1 dB < 6 dB

No Interaction

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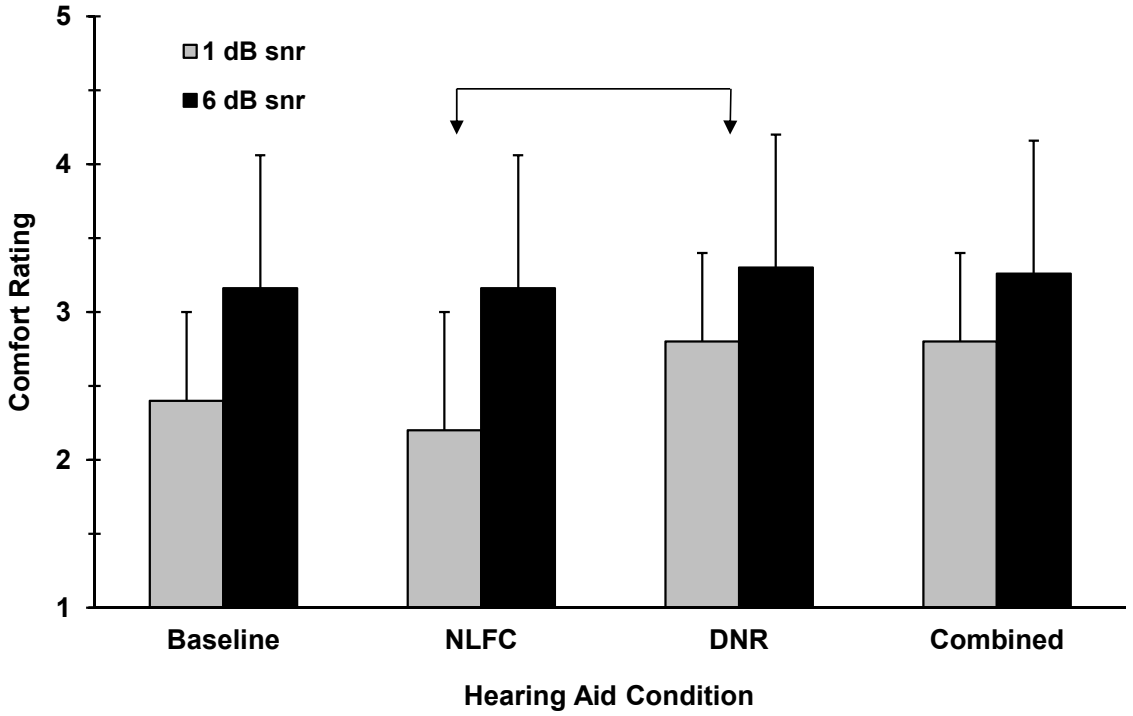
Results—Comfort Rating



Significant Hearing Aid effect

NLFC < DNR

Significant SNR effect

1 dB < 6 dB

No Interaction

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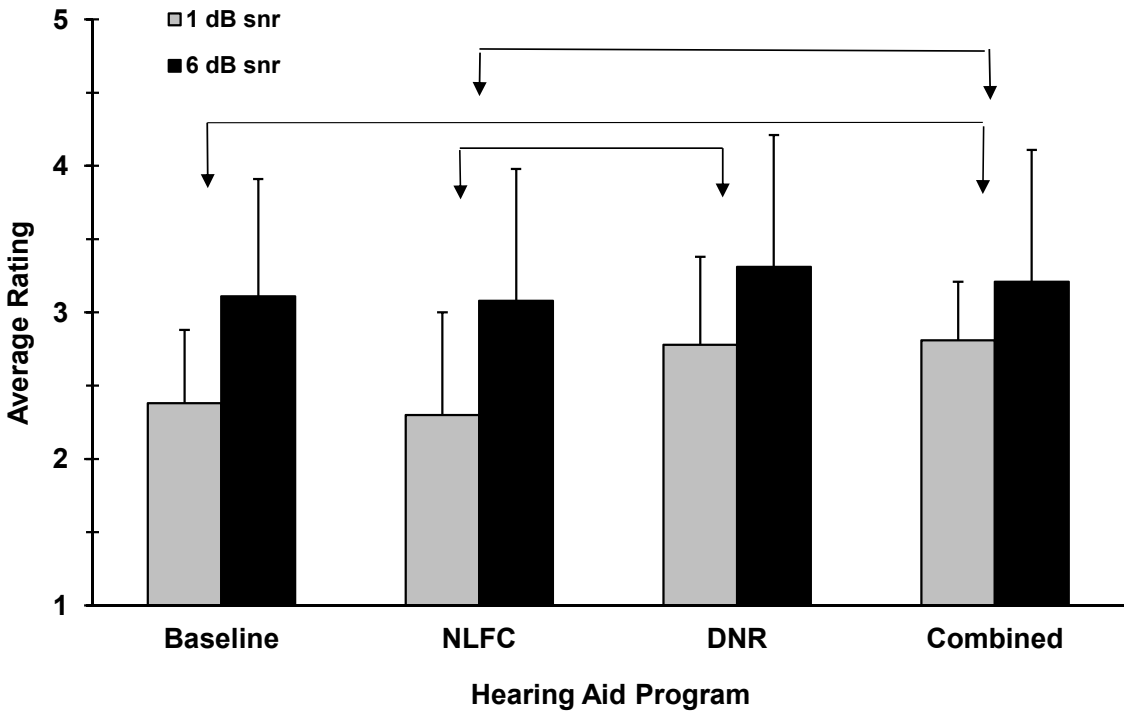
Results—Average Rating



Significant Hearing Aid effect

NLFC < DNR & Combined

Baseline < Combined

Significant SNR effect

1 dB < 6 dB

No Interaction

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Results

- Age & Hearing Loss
  - Benefit with NLFC and/or DNR was not related to the age of the listener
  - Average satisfaction increased as the degree of high-frequency hearing loss increased for DNR and Combination

What does any of this mean?

- Does the isolated or combined use of NLFC and DNR improve word recognition in noise?
  - *NO: NLFC and/or DNR did not improve nor degrade word recognition in noise relative to not using the features*
  - Findings did not support either hypothesis

What does any of this mean?

- Possible explanations
  - NLFC and DNR effects were not large enough to be detected by the listener
    - Satisfaction ratings do not support this explanation
  - Listeners with less hearing loss received no benefit from the features whereas listeners with more hearing loss received significant benefit from the features thus cancelling out the effects
    - degree of hearing loss was not correlated with benefit from NLFC, DNR, or the combined use for word recognition in noise

What does any of this mean?

- Possible explanations
  - Findings with simultaneous use of NLFC and DNR were consistent with their use in isolation
    - In isolation, features revealed no effect on word recognition
      - NLFC did not improve access to high-frequency speech information
      - DNR did not reduce noise (to improve word recognition)
      - DNR did not reduce speech sounds (to degrade word recognition)
    - Taken together, the isolated and simultaneous use of NLFC and DNR did not positively or negatively impact word recognition in noise

What does any of this mean?

- Does the isolated or combined use of NLFC and DNR improve satisfaction ratings in noise?
  - *YES: listener satisfaction was affected by the hearing aid conditions for word clarity, word comfort, and average satisfaction*
    - DNR improved all satisfaction ratings when compared to NLFC
    - DNR + NLFC improved satisfaction ratings when compared to NLFC for clarity and average satisfaction

What does any of this mean?

- Possible explanation
  - DNR was similar to the Baseline and Combined conditions on each satisfaction measure
  - The positive effects in the Combined conditions were due to DNR, not NLFC
    - the positive attributes of DNR outweighed any negative effects produced by NLFC
  - Agrees with previous studies
    - DNR improved listening comfort, effort and noise acceptance

Importance of Subjective Measures

- Word recognition
  - No hearing aid effect
- Satisfaction ratings
  - Significant hearing aid effects
- Explanation
  - qualitative vs quantitative
  - hearing aid conditions did not impact the quantity of speech sounds identified correctly or the categorization of phonemes but did significantly alter the sound quality of the speech

Limitations

- No measure of overall preference
- Adults only
- No field-trial
  - Would findings generalize to real-world?
- Hearing aid settings
  - limited to the hearing aids and test conditions used
  - may not generalize to updated versions of the technology

Take Home Points

- Previous research
  - performance with NLFC or DNR varied significantly
  - attributed to factors such as:
    - the type of outcome measures used
    - variability in fitting protocols
    - degree of hearing loss
    - configuration of hearing loss
    - age of the hearing aid user

Take Home Points

- Current Research
  - Stimuli contained high-frequency information with noise-like modulation patterns
    - sensitive to NLFC and DNR
  - Pilot testing confirmed the stimuli engaged the NLFC and DNR
  - NLFC was verified and adjusted for each ear
  - The participants had
    - sloping audiometric configurations
    - degree of high-frequency hearing loss ranged from 48 to 100 dB HL
    - average age of the participants was 73 years
  - Therefore, it is unlikely the results obtained in the current research were confounded by these factors noted in previous studies

Take Home Points

1. Activating NLFC or DNR in isolation or in combination did not significantly impact word recognition in noise

2. Activating NLFC in isolation reduced satisfaction ratings relative to the DNR or Combination conditions

3. NLFC should not be used in isolation and should be coupled with DNR for best results

Clinical Implications

- NLFC in Isolation
  - Generally a bad thing
  - No impact on speech understanding
    - Positive or negative
    - Consistent with previous research
  - Reduced subjective performance relative to DNR
  - NLFC verification
    - Is NLFC needed?
    - Is NLFC effective?

Clinical Implications

- DNR in Isolation
  - Generally a good thing
  - No impact on speech understanding
    - Positive or negative
    - Consistent with previous research
  - Improved subjective performance relative to NLFC
  - Parameters
    - DNR verification?
    - Amount, frequency range, time constant?

Clinical Implications

- NLFC & DNR in Combination
  - Generally a good thing
  - No impact on speech understanding
    - Positive or negative
  - Improved subjective performance relative to NLFC
    - Positives of DNR outweighed negatives of NLFC
  - IF using NLFC
    - Couple with DNR for best results

Questions?

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Extended Input Dynamic Range

The Effects of Extended Input Dynamic Range on Laboratory and Field-Trial Evaluations in Adult Hearing Aid Users

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Background

- Analog Hearing Aids
  - Peak Clipping
    - limited the maximum output & prevented loudness discomfort
    - harmonic and intermodulated distortion
    - reduced sound quality and speech intelligibility
  - Compression limiting
    - alternative to peak clipping
    - control the maximum output
    - minimize distortion
      - improve sound quality, speech intelligibility & comfort

Background

- Digital Hearing Aids
  - Process signals differently
    - similar components (microphones and receivers)
  - Conversion
    - signal from the microphone(s) converted to a digital format
      - analog-to-digital converter (ADC)
      - processed by the digital signal processor (DSP)
    - output of the DSP converted to analog format
      - digital-to-analog converter (DAC)
- Microphone → A/D → DSP → D/A → Receiver

Background

- Minimize Digital Distortion
  - Input must be accurately converted by the ADC
  - If not, the processed signal will be distorted regardless of DSP applied
    - "front-end peak clipping"
  - ADC ability can impact
    - sound quality
    - sound clarity

Background

- Input Dynamic Range
  - 16-bit ADC
    - 96 dB input dynamic range
  - ADC peak clips input signals
    - 95 and 105 dB SPL
  - Commonly encountered inputs
    - accurately reflected by the ADC
    - speech ranging from 50 dB SPL (soft) to 80 dB SPL (loud)
      - unlikely to be distorted due to ADC peak clipping

Background

- Higher level inputs
  - More susceptible to ADC peak clipping
  - Hearing aid users may be exposed to:
    - music with RMS intensity levels of 100–105 dB SPL
    - shouted speech and music of 102 and 122 dB SPL respectively
      - instantaneous peak levels
  - Hearing aid users & ADC peak clipping
    - concerts, sporting events, movie theatres, parties, or crowded restaurants

Background

- Preventing front-end distortion
  - Shift ADC operating range upwards
    - Increases the upper limit above which distortion occurs
  - Stated differently:
    - 96 dB dynamic range created by the 16-bit ADC
      - input dynamic range of 7-103 dB SPL
      - input dynamic range of 17-113 dB SPL

Background

- Oeding & Valente (2015)
  - Evaluated increasing upper limit of ADC
    - 10 experienced users
  - Laboratory Testing
    - word recognition & sound quality
    - NU 6 & music recordings made on a KEMAR
    - Widex aids (Clear, Dream)
      - programmed for a flat 50 dB loss
      - 103, 106, & 109 dB-C inputs
      - -3, 0, & 3 dB SNRs

Background

- Oeding & Valente (2015)
  - Laboratory Testing
    - listened to recordings
      - headphones
      - tolerable level
  - Results
    - Increasing the upper limit of the ADC
      - significantly improved word recognition for each SNR
      - preferred for speech and noise at high levels

Background

- Oeding & Valente (2015)
  - Field Testing
    - fit with 2 sets of aids
      - with extended range
      - without extended range
    - fit using the individual participant's audiogram
      - NAL-NL1
      - Verified with probe microphone
    - two month trial period
      - alternating between sets every two weeks

Background

- Oeding & Valente (2015)
  - Results
    - no hearing aid differences
      - Speech, Spatial, and Qualities of Hearing Scale
      - Listening at Loud Levels questionnaire
      - overall preference
  - Concluded
    - increasing the ADC upper limit
      - improved word recognition and sound quality preferences in the laboratory
      - effects were not evident in more real-world settings

Background

- Limitations noted by Oeding & Valente (2015)
  - Laboratory testing
    - recordings from hearing aids set for a flat 50 dB loss
    - presented via earphones
      - levels much lower than levels used to obtain the recordings
  - Field testing
    - custom fitted with hearing aids
    - rarely encountered input levels high enough to test the feature
    - unable to directly compare aids under identical conditions

Background

- Alternative Approach
  - Automatic gain control (AGCi)
    - minimize front-end distortion
    - reduce the input signal prior to reaching the ADC
    - input signal is kept below the distortion limit of the ADC
  - Previous research
    - compression limiting more beneficial than peak clipping
      - speech perception for listeners with mild to moderate hearing loss
    - compression limiting and peak clipping both degraded sound quality
  - Unclear at the ADC stage

Background

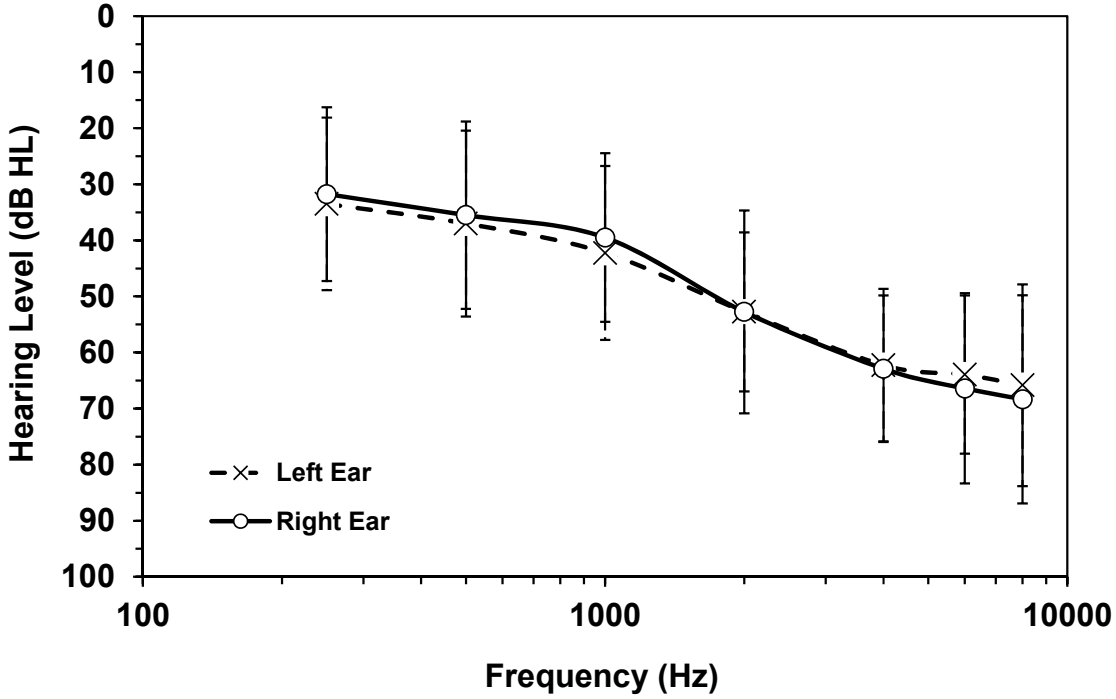
- Alternative Approach
  - Oticon Opn
    - utilizes the AGCi approach to minimizing front-end distortion
    - Dynamic iAGC
  - Purpose
    - Does the Dynamic iAGC approach to extended input dynamic range (EIDR) improve performance and preference of listeners using hearing aids under realistic and repeatable test conditions both within and outside the laboratory setting?

Background

- Research Questions
  - Does the Dynamic iAGC approach to EIDR
    - improve speech perception in noise and listener satisfaction within the laboratory setting?
    - improve subjective performance and listener satisfaction outside the laboratory setting?
    - affect overall listener preference?

Methods

- Participants
  - 20 current users
    - 18 open fit BTE
    - 1 ITE
    - 1 CIC
    - 4 manufacturers
  - Mean 62 years of age
    - 30 – 71 year range



Methods

- Hearing Aids
  - Oticon Opn
  - Receiver in the ear canal devices
  - Receiver and dome type
    - selected using standard clinical procedures
    - same combination used for both sets of devices per participant
    - identical in appearance
  - Features
    - directional microphones, digital noise reduction, and expansion were activated
      - maximize ecological validity
    - Adaptive feedback cancellation was activated
      - maximize high-frequency amplification

Methods

- Hearing Aids
  - 2 sets of Oticon Opn aids
    - EIDR OFF
    - EIDR ON
  - EIDR ON
    - Dynamic iAGC
      - initiated for inputs of 80 dB SPL or higher
      - reduced the input signal prior to reaching the ADC
      - after the ADC stage, gain was added to restore the output to the intended level
      - extended the upper limit of the input dynamic range from 85 dB to 103 dB SPL

Methods

- Hearing Aid Fitting
  - National Acoustics Laboratory-Nonlinear 1
    - 1 memory only
  - Verification
    - Audioscan Verifit Open (speech at 55, 65, 75 & MPO)
    - Match targets using a criteria of +/- 6 dB from 500 – 4000 Hz
  - 2 Trial periods
    - 2 weeks each (counterbalanced)
      - EIDR OFF
      - EIDR ON
  - Single blind design

Methods

- Laboratory Evaluations
  - Speech Perception in Noise
    - Connected Speech Test (CST)
    - Hearing in Noise Test (HINT)
      - Noise fixed, speech adaptive
        - » Ensured noise activated EIDR feature
    - Acceptable Noise Level (ANL)
      - Speech fixed, noise adaptive
        - » Ensured speech level activated EIDR feature

Methods

- Laboratory Evaluations
  - Conducted after each trial period
  - Speech → 0 degrees azimuth
  - Noise → 0 and 180 degrees azimuth
  - Procedures

Test	Speech	Noise
CST	85 dB C	80 dB C
HINT	80 dB C (adaptive)	85 dB C (fixed)
ANL	85 dB C (fixed)	65 dB C (adaptive)

Methods

- Laboratory Evaluations
  - Satisfaction Ratings
    - sound pleasantness, clarity and comfort
    - five-point scale
    - speech in quiet, speech in noise,
      - AV version of the ANL test
        - » Quiet (85 dB C), noise (5 dB SNR)
    - music
      - Rocky Top (85 dB C)

Satisfaction Ratings
1 = very unsatisfied
2 = unsatisfied
3 = neutral
4 = satisfied
5 = very satisfied

Methods

- Field Trial Evaluations
  - APHAB
    - after each trial period
  - Satisfaction Ratings
    - sound pleasantness, clarity and comfort
      - at home 5 times each week
    - speech in quiet & music (85 dB C)
    - same five-point scale
  - Preference & Importance

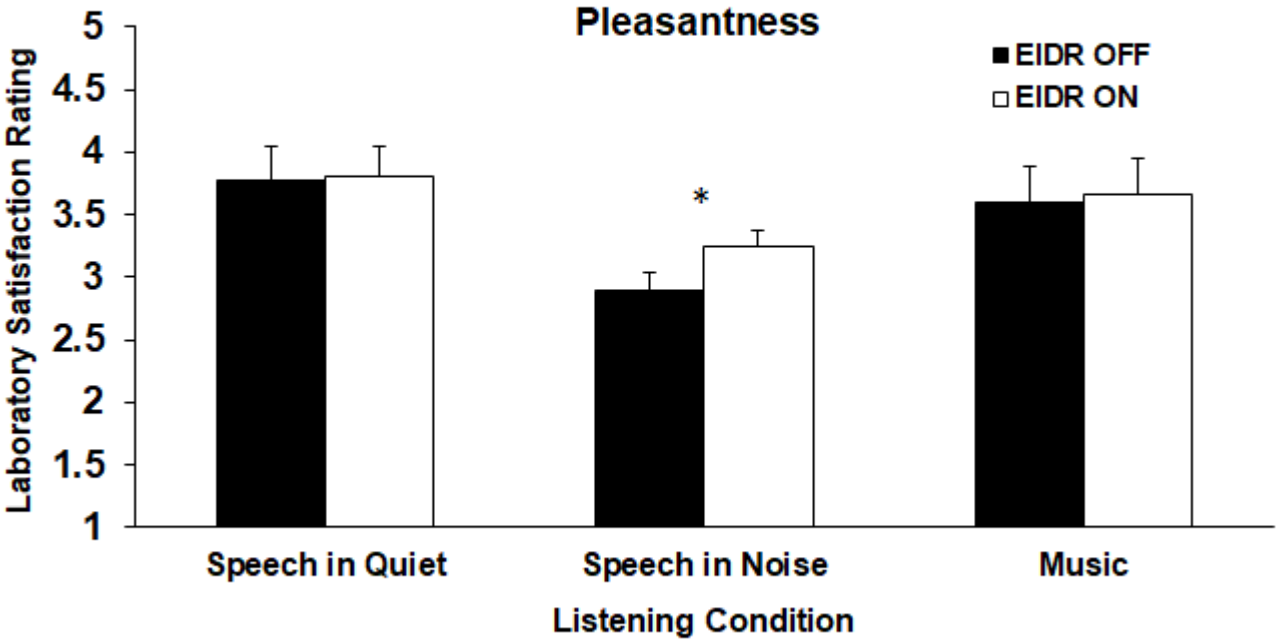
Laboratory Results: Speech in Noise

Speech Perception Measure	EIDR ON	EIDR OFF
Connected Speech Test	54.0% (18)	56.5% (23)
Hearing in Noise Test	3.7 dB (2.3)	3.8 dB (1.8)
Acceptable Nosie Level	6.4 dB (4.3)	7.0 dB (6.2)

Mean results and standard deviations

No EIDR effect for any speech perception in noise measure.

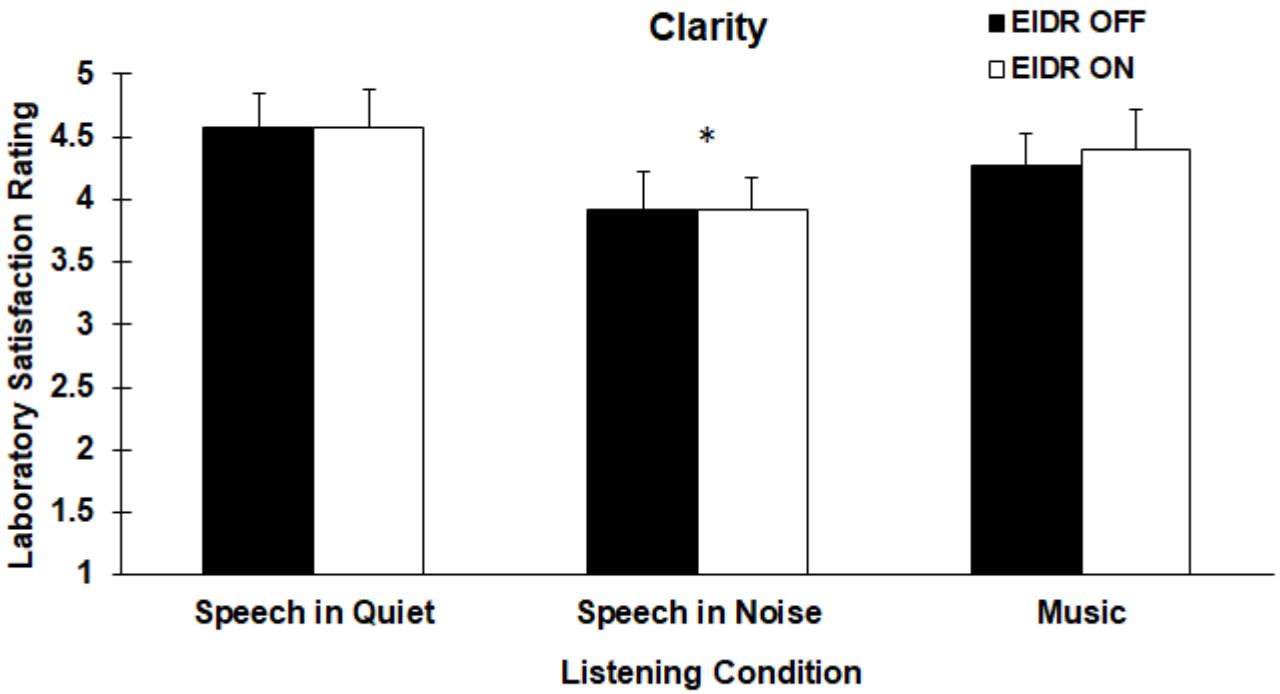
Laboratory Results: Satisfaction



Significant listening condition effect

No EIDR effect

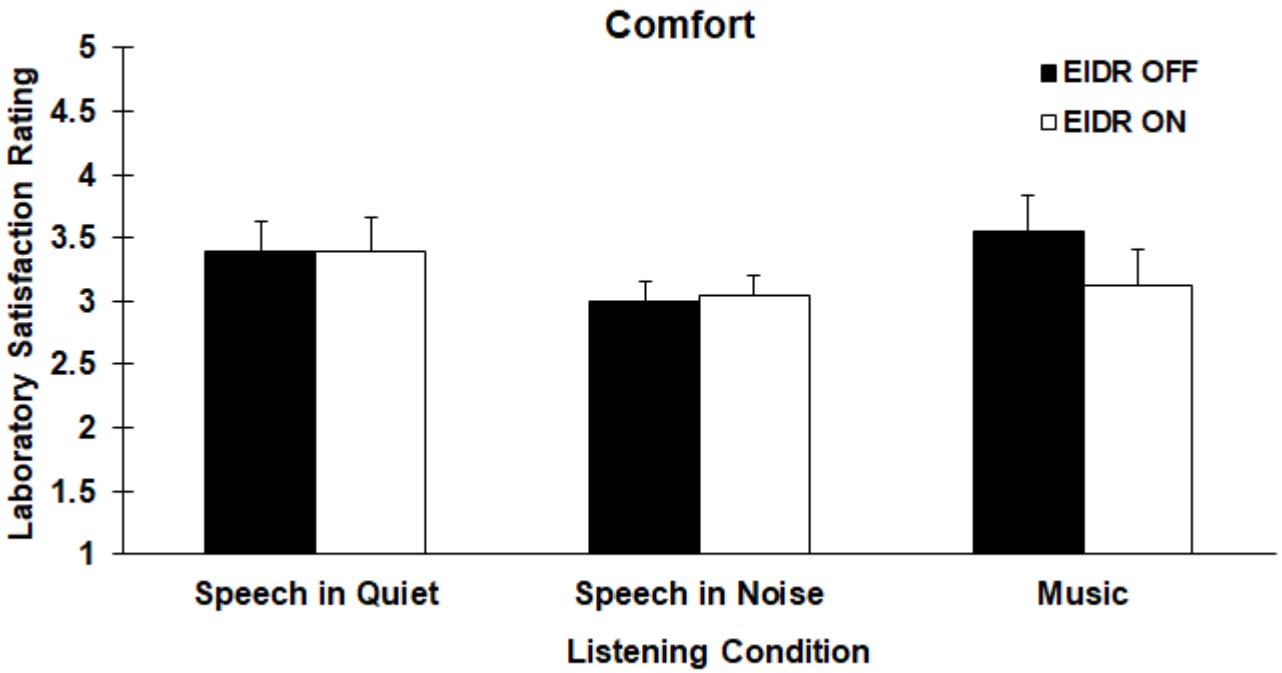
Laboratory Results: Satisfaction



Significant listening condition effect

No EIDR effect

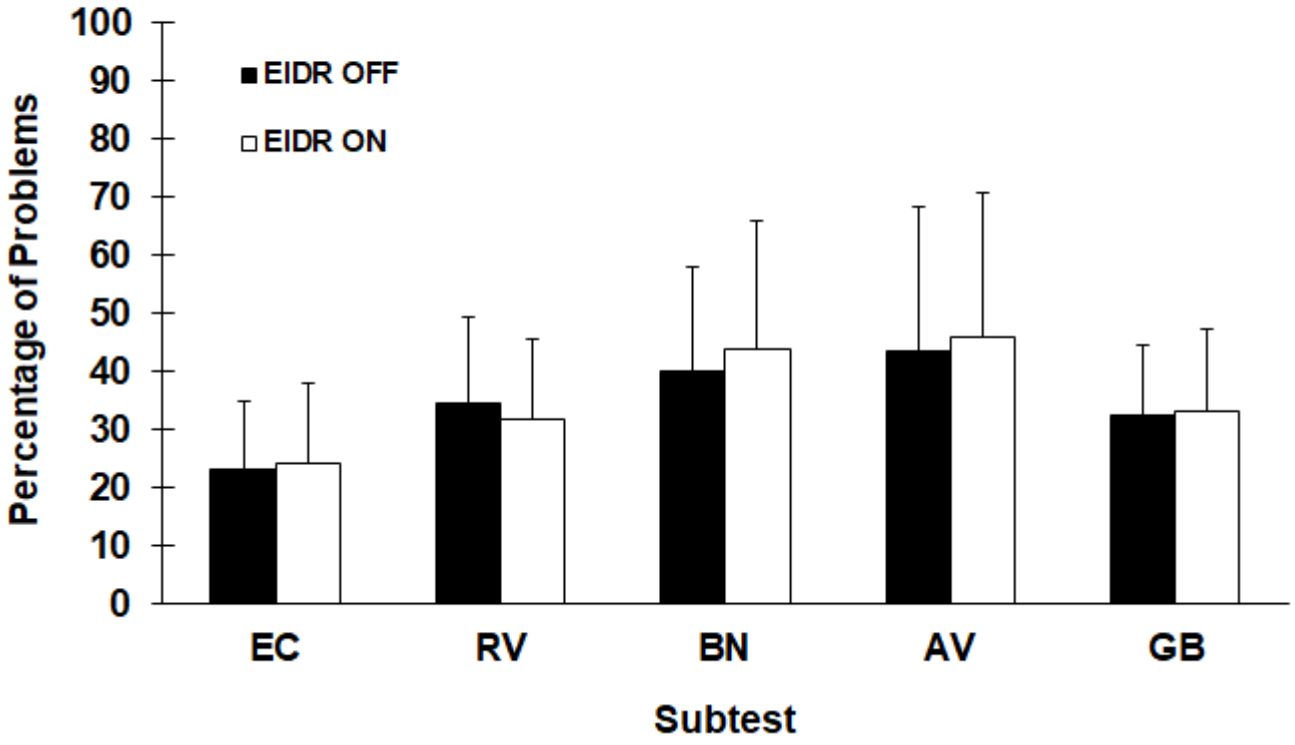
Laboratory Results: Satisfaction



No listening condition effect

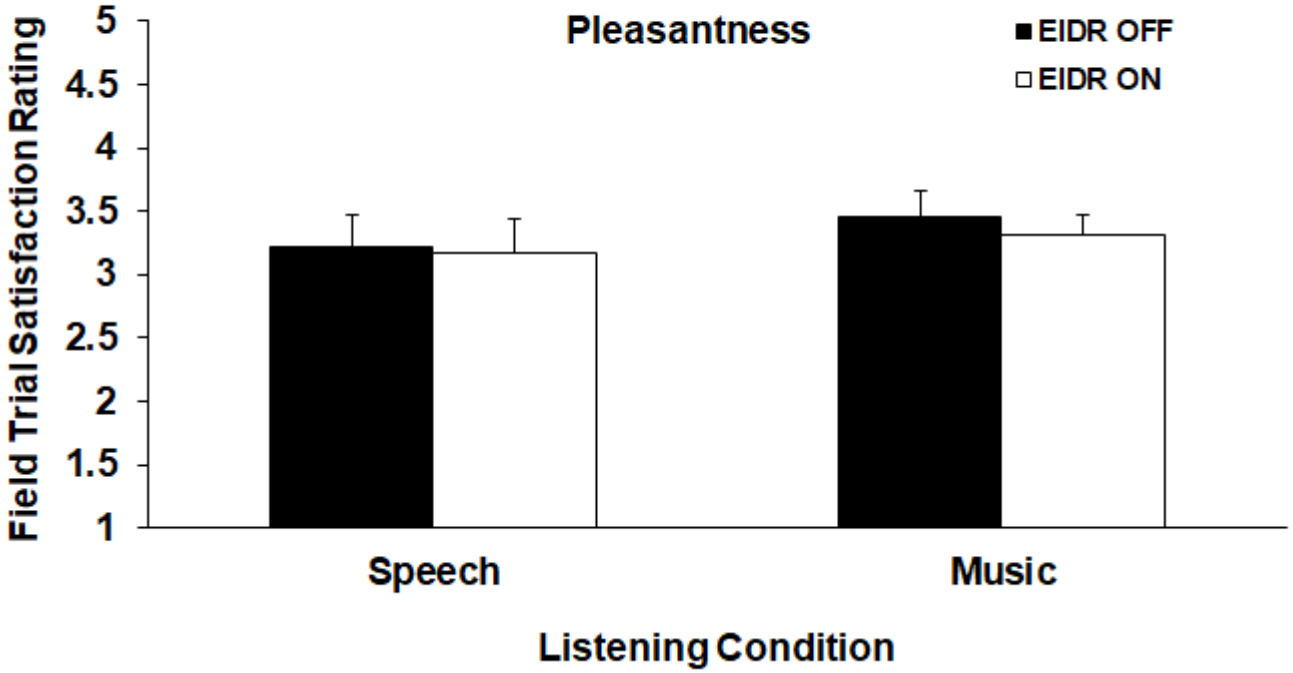
No EIDR effect

Field Trial Results: APHAB



No EIDR effect

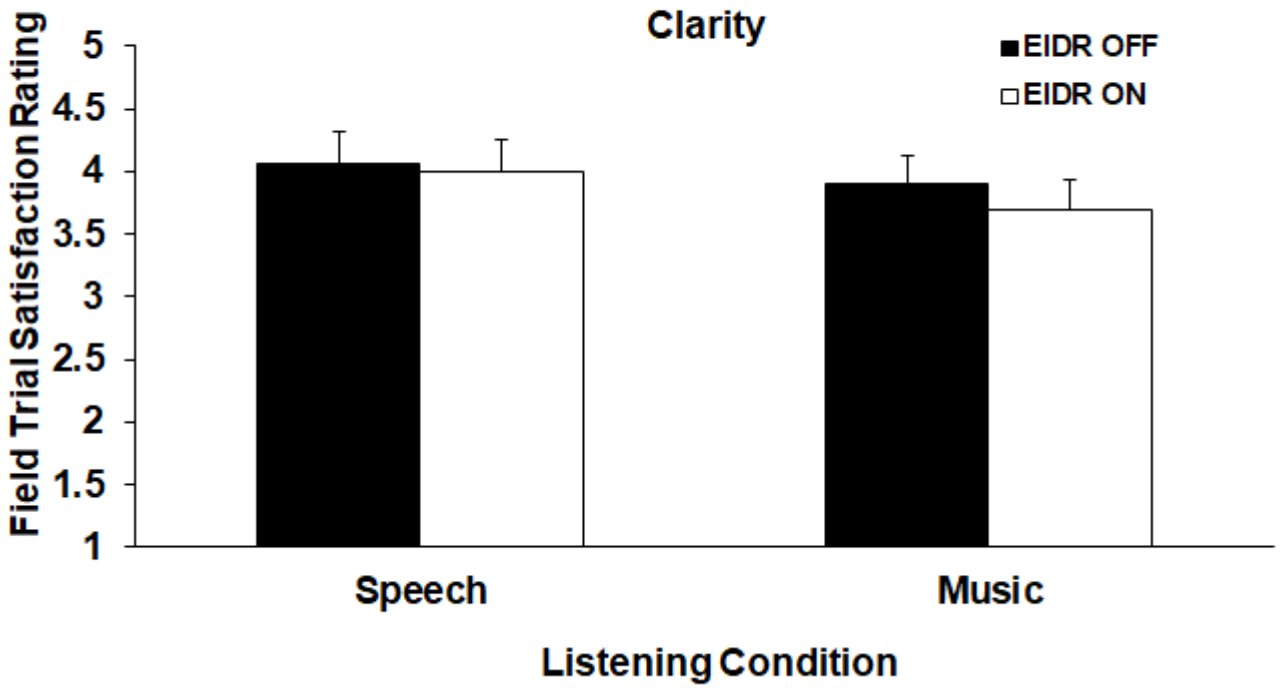
Field Trial Results: Satisfaction



No listening condition effect

No EIDR effect

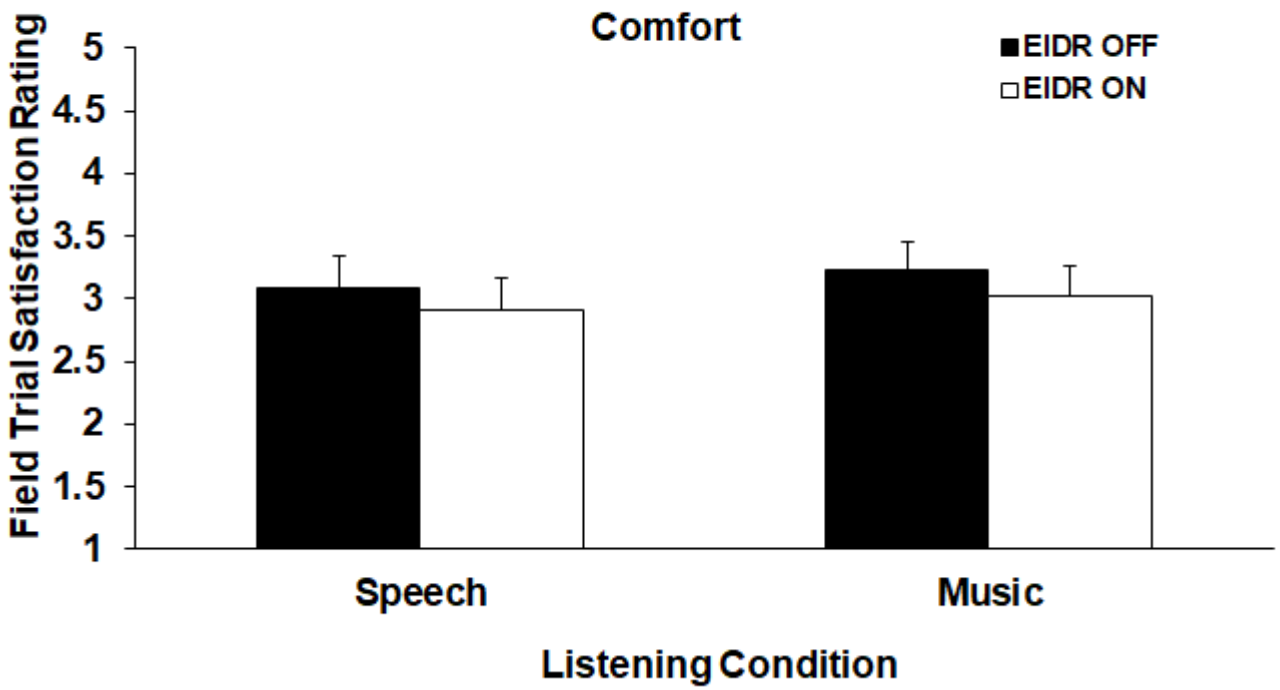
Field Trial Results: Satisfaction



No listening condition effect

No EIDR effect

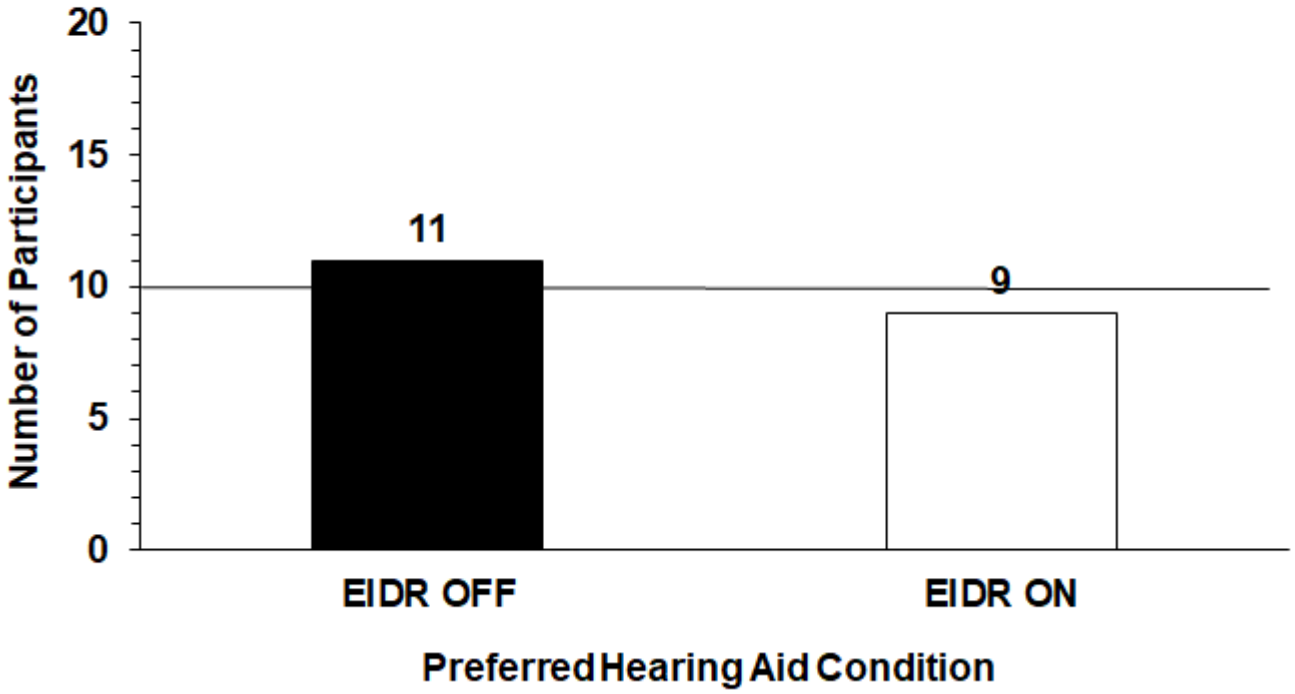
Field Trial Results: Satisfaction



No listening condition effect

No EIDR effect

Field Trial Results: Preference



No EIDR effect

Field Trial Results: Importance

Significant category effect

Clarity received 15 of 20 top-rankings

What does any of this mean?

- Does the Dynamic iAGC approach to EIDR improve speech perception in noise and listener satisfaction within the laboratory setting?

  - *NO: EIDR did not significantly improve or degrade speech perception in noise or listener satisfaction within the laboratory setting*

  - Findings were not consistent with Oeding & Valente (2015)
    - Reported EIDR improved performance

What does any of this mean?

- Possible Explanation
  - Methodological differences between the studies
    - Oeding & Valente (2015)
      - Recordings on KEMAR
      - Flat 50 dB loss
      - Earphones with broader bandwidth
      - Listening levels lower than those used to make recordings
    - Plyler et at (in press)
      - Custom fit hearing aids
      - Stimuli delivered via loudspeaker
      - Listened through hearing aids

What does any of this mean?

- Possible Explanation
  - Input levels used
    - Oeding & Valente (2015)
      - 103, 106, & 109 dB C
      - saturated the hearing aids--only reflected the EIDR
    - Plyler et at (in press)
      - 85 dB C--hearing aids provided additional amplification in many Hz regions
  - Benefit of EIDR may increase at saturation
    - participants with poorest hearing may receive the most benefit
      - No correlation between EIDR benefit and Pure Tone Average

What does any of this mean?

- Possible Explanation
  - Fittings
    - Oeding & Valente (2015)
      - KEMAR—custom earmold with 1mm vent
      - Flat 50 dB loss
        - » Would allow for low frequency processing
    - Plyler et al (in press)
      - Standard audiological practice
      - Open domes
        - » Less low frequency processing

What does any of this mean?

- Does the Dynamic iAGC approach to EIDR improve subjective performance and listener satisfaction outside the laboratory setting?

  - *NO: EIDR did not significantly improve or degrade subjective performance or listener satisfaction outside the laboratory setting*

  - Findings were consistent with Oeding & Valente (2015)
    - Reported no EIDR effect

What does any of this mean?

- Possible Explanation
  - Methodological similarities between the studies
    - Oeding & Valente (2015) & Plyler et al (in press)
      - Standard audiological practice for field trials
      - differences observed in the laboratory were not evident during the field-trial evaluations
    - Sound levels
      - SLMs ensured proper levels in the field trial
      - Correlations between satisfaction ratings in lab and field

What does any of this mean?

- Does the Dynamic iAGC approach to EIDR affect overall listener preference?

  - *NO: EIDR did not significantly affect overall preference*
  - Findings were consistent with Oeding & Valente (2015)
    - Reported no EIDR effect

What does any of this mean?

- Possible Explanation
  - Wash out?
    - Did participants that preferred EIDR ON have better results with EIDR ON and vice versa?
    - Re-grouped based on preference:
      - No pattern emerged for CST, HINT, APHAB or ratings
      - ANL pattern
        - » ANL has been shown to predict hearing aid use
        - » ANL model predicted hearing aid use pattern with 85% accuracy
        - » ANL values were further examined for each preference group

What does any of this mean?

- Possible Explanation
  - ANL?
    - 16 of 20 participants (80%)
      - preferred the EIDR with lower (better) ANL value
    - Preferred Device
      - ANL value = 5.4 dB
    - Rejected Device
      - ANL value = 7.7 dB
    - It is possible the ANL may have captured that individual preference

What does any of this mean?

- Limitations
  - Hearing Aid Experience
    - Is EIDR more salient to new users?
  - Input Level
    - Is EIDR more beneficial at higher input levels?
      - More problematic for ADC
  - Live Music
    - Is EIDR more important for live performances?
      - Recorded music has smaller dynamic range due to compression used in the music industry

Take Home Points

1. EIDR did not significantly improve or degrade speech perception in noise or listener satisfaction within the laboratory setting
2. EIDR did not significantly improve or degrade subjective performance or listener satisfaction outside the laboratory setting
3. EIDR did not significantly affect overall preference

Clinical Implications

- How often are patients in such high levels?
  - Will EIDR ever engage?
  - Should they be using hearing aids?
- Should EIDR be a priority in hearing aid selection?
  - Are there patient profiles for which EIDR is essential?
- Will EIDR become standard moving forward?

Questions?

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CEU Question #1

- The use of frequency compression _____ speech understanding in noise.
  1. improved
  2. degraded
  3. did not impact
  4. randomly impacted

  Answer: 3. did not impact

CEU Question #2

- The use of noise reduction _____ satisfaction ratings in noise when compared to frequency compression.
  1. improved
  2. degraded
  3. did not impact
  4. randomly impacted

  Answer: 1. improved

CEU Question #3

- The use of Extended Input Dynamic Range_____ listener performance inside and outside the lab.
  1. improved
  2. degraded
  3. did not impact
  4. randomly impacted

  Answer: 3. did not impact