Optimization and Evaluation of a Language-Independent Hearing Screening Test based on Sound-Perception-in-Noise

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Study Phases

- Selection of sounds
- Optimization wave 1
- Development and evaluation of adaptive procedure + test validation
- Optimization wave 2
- Optimization wave 3
- Tablet implementation

Future steps:
- Optimization and evaluation of adaptive procedure
  - Investigate sensitivity & specificity of test to detect HI
- Feasibility in children (6 yrs)
Selection of sounds

- Spectro-temporal analysis of sounds and factor analysis (31 sounds)
  - Selection of sounds that resemble speech (BOC-words)
  - Low-pass filtering of sounds to enhance resemblance, provided that it remains recognizable

- 9 sounds selected:
  - Baby*
  - Claxon*
  - Dog
  - Cat
  - Piano
  - Telephone*
  - Church bell*
  - Trumpet*
  - Bird

*filtered
Acknowledgement: Laura Sels (AMC internship)
Optimization Wave 1

- **Goal**: perceptual homogenization of sound material
- **Method**:
  - **Participants**: N = 10 (AMC) + 10 (Leuven) NH adults
    - Thresholds 500 – 4000 Hz ≤ 20 dB HL
  - **Materials**: laptop connected to external soundcard (FireFace UC) - HDA200 Headphones (Sennheiser) – stimuli played via APEX 3.1 software* - quiet room or sound-proof booth
  - **Procedure**: each sound was randomly presented 6x at different fixed SNRs: 0, -5, -8, -10, -12, -14, -16 and -18 dB SNR (noise at 65 dB SPL) – monaurally
  - **Analysis**: PI-curves were fitted, averaged across participants
- AMC evaluated filtered set, KU Leuven evaluated unfiltered set
Optimization Wave 1

- Little differences between both sets: we use **unfiltered** test
- Token-specific level adjustments were done (shift to mean)
  - Adjustments varied between -1.9 to 1.5 dB
Evaluation of Adaptive Procedure

• **Participants**
  o N = 44 NH (thresholds 500 – 4000 Hz ≤ 20 dB HL) + 8 HI
  o 39 ± 16 years (age range: 20-68)

• **Procedure**
  o Pure tone audiometry → PTA\textsubscript{500-4000 Hz}
  o SEC training (monaurally)
    • Each sound was randomly presented 3x at 0 dB SNR with feedback (right or wrong)
  o SEC test-retest (monaurally) → SRT
    • Each sound was randomly presented 3x
    • Level of sounds varied adaptively in 2 dB steps (noise level = 65 dB SPL)
    • Start-SNR = -17 dB, repeat first until correct
  o Digit Triplet Test (KU Leuven) or DIN Test (AMC) (monaurally) → SRT
    • Prototype adaptive SPIN screening test using digits-in-noise
Evaluation of Adaptive Procedure

Data shown: young (<40 yrs) NH participants, N = 29

Test-retest data are pooled

\[ SRT = \frac{\sum_{i=7}^{28} SNR_i}{22} = -12.2 \text{ dB} \]

\[ SD = \frac{1}{\sqrt{22}} \sum_{i=7}^{28} (SNR_i - SRT)^2 = 2.1 \text{ dB} \]

Measurement Error = \[\frac{SD \ (SRT2 - SRT1)}{\sqrt{2}}\] = 0.9 dB
Test Validation

- Significant correlations with PTA and DTT SRT

R = 0.40, p < 0.01

R = 0.42, p < 0.01
Based on the adaptive tracks, PI curves per sound were fitted

Despite previous homogeneization, still **huge variability** in SRTs!
- Level adjustments were done (-1.3 to 2 dB)

Many piano-trumpet confusions
- Trumpet removed from set
Optimization Wave 3

• **Goal:** FINAL perceptual homogenization of sound material

• **Method:**
  - **Participants:** N = 10 NH adults
    - Thresholds 500 – 4000 Hz ≤ 20 dB HL
  - **Materials:** laptop connected to external soundcard (FireFace UC) - HDA200 Headphones (Sennheiser) – stimuli played via APEX 3.1 software* - quiet room or sound-proof booth
  - **Procedure:** after training experiment, each sound was randomly presented 12x at different fixed SNRs: -9, -11, -13, -15, -17 dB SNR (noise at 65 dB SPL) – monaurally
  - **Analysis:** PI-curves were fitted, averaged across participants
Optimization Wave 3

- Little variability in SRT (homogeneous set)
- Steep slope!
- Final adjustments were done (-0.5 to 0.5 dB)
Tablet Implementation

- **DD45 transducer in peltor cups**
- **7” Samsung Galaxy Tablet**
- **Cloud storage of results**

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### De gehoortest

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- Geef telkens drie cijfers in en klik daarna op Ok.
- Indien je niets hebt verstaan, moet je gokken.
- Je kunt een fout corrigeren door op de rode knop te tikken.
Questions?

Contact information: sam.denys@kuleuven.be

Online hearing test: m.testjegehoor.be