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Publication date:
2018

Document version
Final published version

Citation for published version (APA):

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Download date: 18. Apr. 2021
Hearing aid processing strategies for listeners with different auditory profiles: Insights from the BEAR project

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**BEAR outline**

- **Time frame:** 2016-2021
- **Funding:** Innovation Fund Denmark (~4.5m $), Danish hearing industry (~2.3m $), other project partners (~1m $)
- **Purpose:** Improve hearing rehabilitation through evidence-based renewal of clinical practice

**Phase 1: Recruitment, method development**
- WP1: Centralized clinical database ($N = 2000$)
- WP2: New aided performance measures
- WP3: New clinical profiling and fitting strategies

**Phase 2: Apply new methods**
- WP4: Validation of new fitting strategies (field study)
- WP5: Subpopulations with abnormal aided benefit

**Phase 3: Evaluate and iterate**
- WP6: Improved clinical efficiency
- WP7: Patient-driven diagnostics and fitting

**Phase 4: Implement and disseminate**
- WP8: Revised standards for diagnostics and fitting

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**New clinical profiling & fitting strategies**

- **Participants**
  - **Aim:** $N = 2 \times 30$ habitual HA users

- **Study design**

![Diagram showing the study design process](image)
Hypothesis & test battery

- Classification of listeners into small number of auditory profiles
- Beyond audibility: Supra-threshold distortions (e.g. Plomp, JASA 1978)

Temporal resolution deficit?

Distortion Type I

Profile A

Profile B

Profile C

Profile D

Distortion Type II

Spectral resolution deficit?

Auditory profiling

- Data-driven classification based on dimensionality reduction followed by archetypal analysis (Sanchez-Lopez et al, Trends Hear, under review)
HA fitting evaluation

- Test setup: Virtual acoustics, ‘realistic’ HA simulator
  - Comprehensive instrumental evaluation
    - SNR improvement, temporal and spectral distortion, speech intelligibility and quality
    - Spatially diffuse cafeteria noise, target signal from 0° or 90°, various input SNRs and standard audiograms (Bisgaard et al, 2010)

Instrumental evaluation

- Selection of six candidate settings
  - Objective: Maximize differences through the use of different HA parameter sets
  - Omni, NR off, slow compression
  - Omni, strong NR, fast compression
  - Bin. beamformer, NR off, slow compression
  - Bin. beamformer, strong NR, slow compression
  - Bin. beamformer, strong NR, fast compression
  - Cardioid, mild NR, slow compression

(Sanchez-Lopez et al, Euronoise 2018)
Perceptual evaluation

- **Stimuli**
  - Target speech: Sentences from 0° or 90°
  - Speech-like interferer from 90° or 0°
  - Spatially diffuse cafeteria noise

- **Speech-in-noise reception**
  - Individual SRT<sub>50</sub> measurements, then fixed-SNR speech recognition scores; test-retest measurements
  - Overall quality and noise annoyance
  - Multi-stimulus comparison; SRT<sub>50</sub> + 4 dB SNR; four repetitions

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Speech-in-noise reception

- **Auditory profile**
  - A: Omni, NR off, slow compression
  - B: Omni, strong NR, fast compression
  - C: Bin. beamformer, NR off, slow compression
  - D: Bin. beamformer, strong NR, slow compression
  - E: Cardioid, mild NR, slow compression

- **Preliminary statistics**
  - Spatial condition, HA setting, spatial condition \(\times\) HA setting: all \(p < .0001\)
  - Auditory profiles: ???

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Summary

- BEAR project: Unique constellation; large-scale approach
- Auditory profiling
  - Data-driven approach; Reasonably consistent results for two separate datasets
  - More data needed for cross-validation (incl. other audiometric configurations)
- HA fitting evaluation
  - Instrumental evaluation: SNR improvement, temporal and spectral distortion; Selection of six candidate HA settings
  - Perceptual evaluation: Preliminary data show expected effects of spatial condition and HA settings; More data needed for probing auditory profiles

Acknowledgments