Learning Objectives:

1. ... recognize that different signal processing approaches in high-end hearing aids attack the speech in noise problem in different ways.
2. ... develop the ability to glean information about dynamic device performance by looking at various advance visual representations (such as spectrographs, waveforms, etc.)
3. ... recognize that some systems can meet certain performance criteria (such as reduction of noises arising from behind) at the expense of other criteria (such as maintenance of a full gain response).
The Listening Environment

Östen Axelsson, Mats E. Nilsson, and Birgitta Berglund

chart:

- Human Sounds
- Technological Sounds
- Nature Sounds

- Eventful
- Chaotic
- Unpleasant
- Monotonous
- Calm
- Uneventful
- Pleasant

Course presented in partnership with
Osten Axelsson, Mats E. Nilsson, and Birgitta Berglund

<table>
<thead>
<tr>
<th>Human Sounds</th>
<th>Technological Sounds</th>
<th>Nature Sounds</th>
</tr>
</thead>
</table>

Stated annoying sound or sound source

<table>
<thead>
<tr>
<th>Sound Source</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal human sounds</td>
<td>Sounds produced by people, verbal. An example of these sounds is murmuring.</td>
</tr>
<tr>
<td>TV/radio</td>
<td>Sounds emitted from the loudspeakers of TV and/or radio</td>
</tr>
<tr>
<td>Vehicles</td>
<td>Sounds produced by vehicles with engines; cars, trains, motorcycles, etc.</td>
</tr>
<tr>
<td>Machine tools</td>
<td>Sounds produced by e.g. power saw, drilling-machine</td>
</tr>
<tr>
<td>Household appliance</td>
<td>Sounds produced by ordinary household appliances such as washing machine,</td>
</tr>
<tr>
<td></td>
<td>vacuum cleaner, or electric mixer.</td>
</tr>
</tbody>
</table>

Åsa Skagerstrand, Stefan Stenfelt, Stig Arlinger, and Joel Wikström
OpenSound Navigator: Design Purpose

- To improve speech understanding performance in complex environments without unduly sacrificing a natural listening experience
The effect of OpenSound Navigator

Hearing loss with amplification
Hearing loss with OpenSound Navigator
Normal hearing

dB SNR

 Quiet environments
  - Home
  - Family dinner
  - Restaurant

Noisy environments

Le Goff and Beck 2017, Oticon whitepaper, Juul Jensen 2018, Oticon whitepaper

Ohlenforst, et al., 2017
How does it work?

- **Analyze**
- **Balance (DIR)**
- **Noise Removal**

- **Noise Amplification**

- **Mic**
- **Noise**

- **Directional Patterns (DIR)**
Data Captured

- Frequency (16 channels)
- Level
- Location
- Speech versus non-speech

Update speed: 10 msec versus 3 sec
OpenSound Navigator Compared to:

- Traditional DIR & NR:
  Analysis Phase
  Spatially-aware NR
  Criteria for NR changes
  Update Speed

- Beamforming:
  Analysis Phase
  Update Speed
  Protection of clearly defined speech sources

Recordings

- KEMAR recordings
  - Opn 1
  - Beam Former
  - Traditional DIR & NR

- Speech in Speech-shaped Noise (+5 dB S/N)

- Technical Analysis of effect on S/N
Audiometric configuration:

Recordings: Set-up

*Recording Ear

Signal Processing Effect?
Recordings: Set-up

*Recording Ear

Signal Processing Effect?

Unaided

Opn 1

Front  Side  Both
Recordings: Set-up

SS Noise

Speech

*Recording Ear

Signal Processing Effect?
Recordings: Set-up

*Recording Ear

Signal Processing Effect?

Unaided

Opn 1

Noise Stops

35 sec

OTICON
Audiology
Recordings: Set-up

*Recording Ear

SS Noise

Signal Processing Effect?

Recordings: Set-up

Unaided

Opn 1

35 sec
Study: Multiple talkers in noise

- Uncertainty of the target speaker location
- 24 participants
- 3 mRITE HAs with different technologies set to max NR
Results

Speech understanding of center speaker (Sam)

Average speech understanding of speakers from sides (Mike and Diane)
Results
Average speech understanding of 3 speakers

New in Spring of 2019: The Oticon Opn S family
Feedback cancellation in action: Two Phases

*Fast Phase & Long-term Phase*

Velox S™ allows significantly faster detection and response

---

Feedback zone

Sound quality zone

Feedback risk

Risk build-up

Short-term effect (before 0.1 sec.)

Long-term effect (seconds)

No feedback management

Conventional technology

Oticon Opn S™
Two key improvements

- Speed/resolution
- Cancellation technique

Feedback zone
Sound quality zone
Feedback risk

First Breaker Signal

Oticon Opn S™
OpenSound Optimizer and OpenSound Navigator

Methods

Test conditions:
• Front: 70 dB speech
• Back: 70 dB speech-shaped noise

Hearing aid fitting:
• Modified S2 audiogram
• Open domes

Audiometric configuration:
OpenSound Navigator: Design Purpose

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Sony
Blew environments
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Le Golf and Beck 2017, Oticon whitepaper, Juul Jensen 2018, Oticon whitepaper

The Behavior of OpenSound Navigator in Complex Environments

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