Hearing well and being well – a strong scientific connection
Clinical implementation of a listening effort measure (ACALES) - Melanie Krüger

November 14–16, 2019 I Frankfurt am Main, Germany
Listening effort

“the deliberate allocation of mental resources to overcome obstacles in goal pursuit when carrying out a listening task.” (Pichora-Fuller et al., 2016)

- An important factor in cocktail party situation
- Various measurement methods: objective (e.g. pupilometry, EEG) and subjective (scales and questionnaires).
- The practical effect of subjective methods: individual evaluation of the benefits of hearing systems in acoustically demanding everyday situations.
Adaptive Categorical Listening Effort Scaling

- A  = Adaptive
- CA = Categorical
- L  = Listening
- E  = Effort
- S  = Scaling

- Subjective rating of listening effort

- Responses were given on a 13-step scale with an extra category “only noise”
Adaptive Categorical Listening Effort Scaling

- Speech in background noise
  - Matrix sentences test with the structure:


- Three sentences in a row
  - First sentence: First impression of the listening situation
  - Second sentence: Initial information about the perceived listening effort
  - Third sentence: Final decision about the perceived listening effort
Adaptive Categorical Listening Effort Scaling

- Background noise
  - stationary e.g. Olnoise
  - fluctuating e.g. IFFM
  - complex scenarios e.g. restaurant

- Task

  „How much effort is required for you to follow the speaker?“
Adaptive Categorical Listening Effort Scaling

- The ACALES method is divided into three phases (Krueger et al., 2017):

1. Determination of boundaries for „no effort“ and „extreme effort“
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Adaptive Categorical Listening Effort Scaling

- The ACALES method is divided into three phases (Krueger et al., 2017):

1. **Determination of boundaries for „no effort“ and „extreme effort“**
   - „no effort“ (1 ESCU) at 9 dB SNR
   - „extreme effort“ (13 ESCU) at -12 dB SNR
Adaptive Categorical Listening Effort Scaling

- The ACALES method is divided into three phases (Krueger et al., 2017):

  1. Determination of boundaries for „no effort“ and „extreme effort“
  2. Estimation of SNR for categories
Adaptive Categorical Listening Effort Scaling

2. Estimation of SNR for categories

![Graph showing the relationship between SNR and listening effort](image-url)
Adaptive Categorical Listening Effort Scaling

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- The ACALES method is divided into three phases (Krueger et al., 2017):

1. Determination of boundaries for „no effort“ and „extreme effort“
2. Estimation of SNR for categories
3. Recalculation of boundaries and SNRs
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Preliminary study with CI users
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<th>Test</th>
<th>Speech intelligibility</th>
<th>Listening effort</th>
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<td><strong>Result</strong></td>
<td>Threshold for score of 50% (SRT)</td>
<td>Subjective listening effort</td>
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Participants

Group 1: Participants with bilateral CI provision

- Aided free field audiogram separated by ears
- Aided threshold around 30 dB HL
Participants

Group 2: Participants with bimodal provision

- Aided free field audiogram separated by ears
- CI threshold of the better ear around 30 dB HL
- HI threshold up to 1.5 kHz around 30 dB HL and a wider spread for higher frequency
Results: Speech intelligibility

Group 1: bilateral

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<tr>
<td>IFM</td>
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<td>Olnoise</td>
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We help people to hear better.
Results: Speech intelligibility

- Group 1: bilateral
  Improvement of 3.2 dB (IFFM) and 0.7 dB (Olnoise)
Results: Speech intelligibility

- **Group 1: bilateral**
  Improvement of 3.2 dB (IFFM) and 0.7 dB (Olnoise)

- **Group 2: bimodal**
  Improvement of 1.9 dB (IFFM) and 1.5 dB (Olnoise)
Results: Speech intelligibility

Speech intelligibility is better with a bimodal or bilateral provision
Results: Speech intelligibility

- **Group 1: bilateral**
  Two participants with no benefit of the bilateral provision

- **Group 2: bimodal**
  Participant #15 has no benefit of the bimodal provision in both noises
  Another participant with no benefit
Results: Listening effort

Measurement data of one participant
Results: Listening effort

Measurement data of one participant with the corresponding listening effort function
Results: Listening effort

Averaged listening effort function for the measurement condition „one CI“

With increasing SNR the perceived listening effort decreases
Results: Listening effort

- **Group 1: bilateral**
  Reduced listening effort with two CIs
Results: Listening effort

- **Group 1: bilateral**
  Reduced listening effort with bilateral provision

- **Group 2: bimodal**
  Reduced listening effort with bimodal provision
Results: Listening effort

- **Group 1: bilateral**
  - All participants have a benefit with a bilateral provision in Olnoise
  - Two participants with increased listening effort in IFFM

- **Group 2: bimodal**
  - Four participants with increased listening effort in Olnoise and IFFM
Summary

- ACALES is fast and easy.
- The adaptive scaling method can be used with CI users.
- ACALES is able to detect differences between CI only and bilateral or bimodal provision.
- It is not possible to make predictions about improvements in listening effort based on benefit in speech tests.
- **Why do some CI users get a benefit from bilateral or bimodal provision and others do not?**
Outlook

- How does the perceived listening effort differ between the participants?

→ Longitudinal study in cooperation with Evangelisches Krankenhaus Oldenburg (Universitätsklinik für Hals-Nasen-Ohren-Heilkunde)
We help people to hear better.

Thank you for your attention!

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