En model for hvordan den enkelte lytter fastlægger sit Acceptable Noise Level (ANL)

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Acceptable Noise Level (ANL)

• A method for quantification of the level of background noise a subject can accept when listening to speech at MCL
  – Used for prediction of individual hearing aid use patterns
    • “I use my hearing aid whenever it is needed”
    • “I use my hearing aid occasionally”/ “I don’t use my hearing aid at all” Nabelek et al (2006)

The chance for success and failure is equal

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<th>ANL</th>
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• Used for evaluation of hearing aid features
  – Directional microphone systems, noise reduction algorithms
The ANL method

• Speech presentation
• Speech set to MCL by test subject
• Add noise to speech
  – Same transducer
  – Speech kept at the selected level
• Noise set to highest acceptable level (BNL) by subject
• ANL = MCL – BNL
Accuracy and precision

Correct value
Measured values
Good accuracy, poor precision

Correct value
Measured values
Good precision, poor accuracy
<table>
<thead>
<tr>
<th>Study</th>
<th>Number of subj</th>
<th>Sessions on the same day</th>
<th>Sessions on separate days</th>
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<td>Freyaldenhoven et al (2006)</td>
<td>30</td>
<td>CR (dB) Max test retest diff (dB)</td>
<td>- 14.3</td>
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<td>CR (dB) Max test retest diff (dB)</td>
<td>6.5 - 8.6 7.1 - 8.8</td>
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<tr>
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<td>7.6 15.4 15.0</td>
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<td>290</td>
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<td>8.5 20</td>
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CR = 1.96 X SD of differences between repeated measures
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What does a CR of 6 dB mean?

| ANL (dB) |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 3        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 4        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 6        | X |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 7        |   | X |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 8        |   |   | X |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 9        |   |   |   | X |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 10       |   |   |   |   | X |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 11       |   |   |   |   |   | X |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 12       |   |   |   |   |   |   | X |   |   |   |   |   |   |   |   |   |   |   |   |
| 13       |   |   |   |   |   |   |   | X |   |   |   |   |   |   |   |   |   |   |   |
| 14       |   |   |   |   |   |   |   |   | X |   |   |   |   |   |   |   |   |   |   |
| 15       |   |   |   |   |   |   |   |   |   | X |   |   |   |   |   |   |   |   |   |
| 16       |   |   |   |   |   |   |   |   |   |   | X |   |   |   |   |   |   |   |   |
| 17       |   |   |   |   |   |   |   |   |   |   |   | X |   |   |   |   |   |   |   |
| 18       |   |   |   |   |   |   |   |   |   |   |   |   | X |   |   |   |   |   |   |
| 19       |   |   |   |   |   |   |   |   |   |   |   |   |   | X |   |   |   |   |   |
| 20       |   |   |   |   |   |   |   |   |   |   |   |   |   |   | X |   |   |   |   |

- **Will probably be a full-time user**
- **Uncertain outcome**
- **Will probably only use hearing aids occasionally or not at all**
What does a CR of 8 dB mean?

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- **Will probably be a full-time user**
- **Uncertain outcome**
- **Will probably only use hearing aids occasionally or not at all**
What does a CR of 10 dB mean?

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- Will probably be a full-time user
- Uncertain outcome
- Will probably only use hearing aids occasionally or not at all
Precision and prediction accuracy

• The precision of the ANL is too poor to show differences of the magnitude that it was designed for.
• It has never been shown that ANL can predict hearing aid use.
Prediction of future HA use

- ANL predicts HA use with 85% accuracy
- A statistical model tends to fit the data upon which it is developed better than on independent data
  

- 25% of listeners would be misclassified with the ANL procedure

  Nabelek et al (2007)
Stimulus:
Speech and noise

Model by Wu et al (2013)
Stimulus: Speech and noise

Feature 1

Feature 2

Feature (n)

Model by Wu et al (2013)
Stimulus: Speech and noise

Feature 1 → W1
Feature 2 → W2
Feature (n) → W(n)

Compare to inherent standard for noise acceptance

Model by Wu et al (2013)
Stimulus: Speech and noise

Model by Wu et al (2013)
Stimulus: Speech and noise

Feature 1 \rightarrow W_1
Feature 2 \rightarrow W_2
Feature (n) \rightarrow W(n)

Compare to inherent standard for noise acceptance

Psychological factors \rightarrow W_p

ANL response

Model by Wu et al (2013)
Stimulus: Speech only

Feature 1

Feature 2

Feature (n)

Compare to inherent standard for noise acceptance

Psychological factors

ANL response

Model by Olsen & Brännström, 2013
Stimulus: Speech only

Feature 2

W1

Feature 1

W2

Feature (n)

W(n)

Compare to inherent MCL standard

Psychological factors

Measurement procedures (Bias)

MCL response

Model by Olsen & Brännström (2013)
Stimulus: Speech only

Feature 1 \( \rightarrow \) \( W_1 \)
Feature 2 \( \rightarrow \) \( W_2 \)
Feature (n) \( \rightarrow \) \( W(n) \)

Compare to inherent MCL standard

Psychological factors

Measurement procedures (Bias)

MCL response

Stimulus: Speech at MCL and noise

Model by Olsen & Brännström, 2013
Model by Olsen & Brännström, 2013
Model by Olsen & Brännström, 2013
Stimulus: Speech only

Model by Olsen & Brännström, 2013
Stimulus: Speech only

1. Feature 1 \( W_1 \)
2. Feature 2 \( W_2 \)
3. Feature (n) \( W(n) \)

Compare to inherent MCL standard

Psychological factors

Measurement procedures (Bias)

MCL response

Stimulus: Speech at MCL and noise

1. Feature 1 \( W_1 \)
2. Feature 2 \( W_2 \)
3. Feature (n) \( W(n) \)

Compare to inherent standard for noise acceptance

Central processes

Psychological factors

Measurement procedures (Bias)

MCL response

Model by Olsen & Brännström, 2013
Stimulus: Speech only
- Feature 1 \( W_1 \)
- Feature 2 \( W_2 \)
- Feature (n) \( W(n) \)

Compare to inherent MCL standard
- Psychological factors
- Measurement procedures (Bias)

MCL response

Stimulus: Speech at MCL and noise
- Feature 1 \( W_1 \)
- Feature 2 \( W_2 \)
- Feature (n) \( W(n) \)

Compare to inherent standard for noise acceptance
- Central processes
- Psychological factors
- Measurement procedures (Bias)

BNL response

Model by Olsen & Brännström, 2013
Stimulus:
- Speech only
  - Feature 1
  - Feature 2
  - Feature (n)
- Speech at MCL and noise
  - Feature 1
  - Feature 2
  - Feature (n)

Central processes
Psychological factors
Measurement procedures (Bias)

Comparison to inherent MCL standard

Model by Brännström et al, 2013
Summary

• Our ANL model includes effects of
  – measurement procedures
  – psychological factors
  – WMC and central auditory processes
• The model demonstrates why ANL may not be related to HA use.
• Future research should propose improvements of the ANL method.


Holm, L., Kastberg, T. Stabilitet för Acceptable Noise Level (ANL) hos normalhörande vuxna personer vid upprepad mätning inom samma testsession och dess relation till arbetstminneskapacitet. Vetenskapligt arbete, Avdelningen för logopedi, foniatri och audiologi Institutionen för kliniska vetenskaper, Medicinska Fakulteten, Lunds Universitet, Lund. [In Swedish]


