Analysis of the individual listening effort reflected by the pupillary responses during speech perception in noise
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Introduction
Listening effort can be reflected in the enlarged pupil size. It has been found e.g. during speech perception in noise with use of commonly known measures such as the peak or mean pupil dilation. Recent pupillometry studies investigate further time-dependent aspects of the pupillary response through Growth Curve Analysis (GCA). This study aims to classify the individual listening effort reflected in the pupil size based on the GCA outcome measures.

Pupillometry Data
Pupillary responses were recorded while listeners performed a Danish Speech-in-Noise test at either 50% or 95% correct recognition in a 4-talker babble, divided into two independent data sets:
- Training (D1) – 22 listeners, 25 trials per condition,
- Test (D2) – 18 listeners, 25 trials per condition.

Methods Used to Classify Individual Listening Effort
Pupil Features
GCA based on the 3rd order polynomial model with varying intercept was used to extract relevant pupil features: intercept - 0th, slope - 1st, quadratic - 2nd and cubic - 3rd order polynomials.

Additional features:
- Pupil Peak Dilation – maximum pupil size,
- Congruence – measure of likeness between an individual response and the group average.

Classification Facts
1. Input: Pupil features – GCA, PPD, Congruence, Condition.
2. Output: Classification of the high/low effort pupil responses.
4. Classifiers: Decision Trees (DTs) trained on D1 and tested on D2.
5. Quality Assurance: Congruence was tested at the sentence level, where high/low effort examples were excluded from classification for <60% congruent trials. Thus, modified data sets were:
   - Training (D1m) – 17 listeners,
   - Test (D2m) – 14 listeners.

Results
Classification accuracy in detection high/low individual listening effort based on the pupillary responses.

Conclusions
- GCA features are effective in quantifying individual listening effort during speech perception in noise task.
- Combined with the other pupil features, they classified 88.5% of the high/low effort examples correctly.
- Congruence analysis improves high/low individual listening effort classification up to 17%.

References