AuDiET: Auditory Diagnostics and Error-based Treatment - Towards performance-based fitting

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Outcome Variability

Unexplained poor performance in Cochlear Implant (CI) users is a problem which is as hard to predict as it is to address. People who could be expected to perform well with a CI may turn out to have suboptimal speech recognition with their implant.

Reducing unexpected poor performance has been difficult so far. **Numerous factors** contribute to speech perception, and several of them, such as aetiology, cannot be intervened upon.

What can, however, be done, is to move towards **individualized care**. Implant fitting and post-intervention rehabilitation are left to the discretion of hospitals and clinics. The lack of standardised, evidence-based clinical practices can then result in **specific individual needs** not being effectively addressed.

Because of this, unexpected poor performance is difficult to address effectively, leaving users dissatisfied with their implants. The **Auditory Diagnostics and Error-based Treatment (AuDiET)** study aims to change this situation by taking steps towards evidence-based clinical practices.

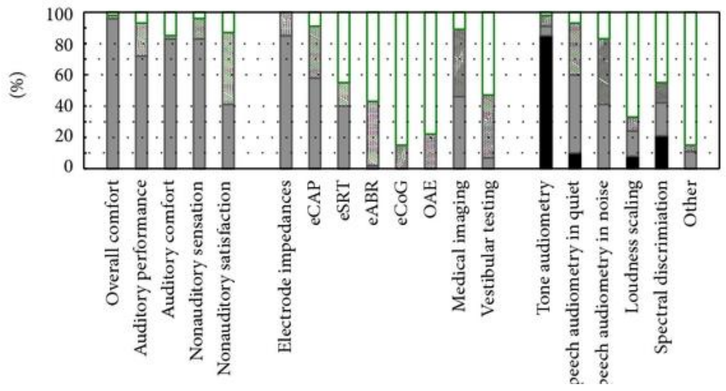

Fig. 1 *How often different outcome assessments are performed (colored bars) and used to optimize fitting (solid colors) in different clinics. (From: Vaerenberg. et al., 2014)[1].*

Confusion Matrices

The Confusion Matrix is valuable Data Science tool for analysing in detail which phonemes a CI user is struggling with.

It is a target-response plot in which each row and column corresponds to a phoneme in a recognition test. Each row corresponds to a presented stimulus, and each column to a response.

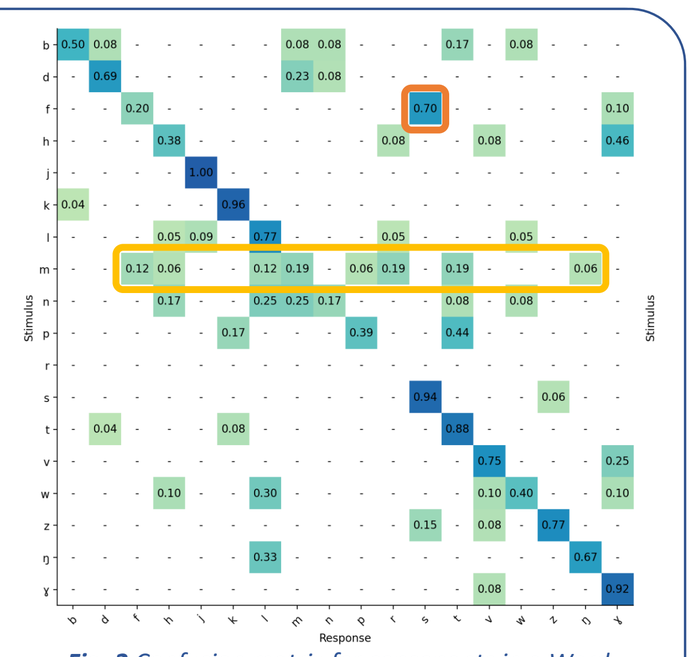

Fig. 2 *Confusion matrix for consonants in a Word Recognition in Quiet test*

The value of cell (X, Y) corresponds to the percentage of times that the subject, when presented with the phoneme X, reported hearing Y. Values on the diagonal correspond to correct answers. A Confusion Matrix can offer precious insight into error patterns by highlighting:

- **Systematic errors**, where a phoneme is predominantly identified as a different one. For example, in Fig.2 /f/ is misclassified as /s/ in 70% of occurrences (highlighted in orange).
- **Random errors**, where instead multiple different errors are made for a single phoneme. For example, in Fig.2 /m/ is misclassified as 8 different phonemes (highlighted in yellow).

The hypothesis to be tested in the AuDiET study is that **different error patterns should be addressed in different ways**.

Research Question: does personalized intervention affect speech recognition, and if so, how?

Study Design

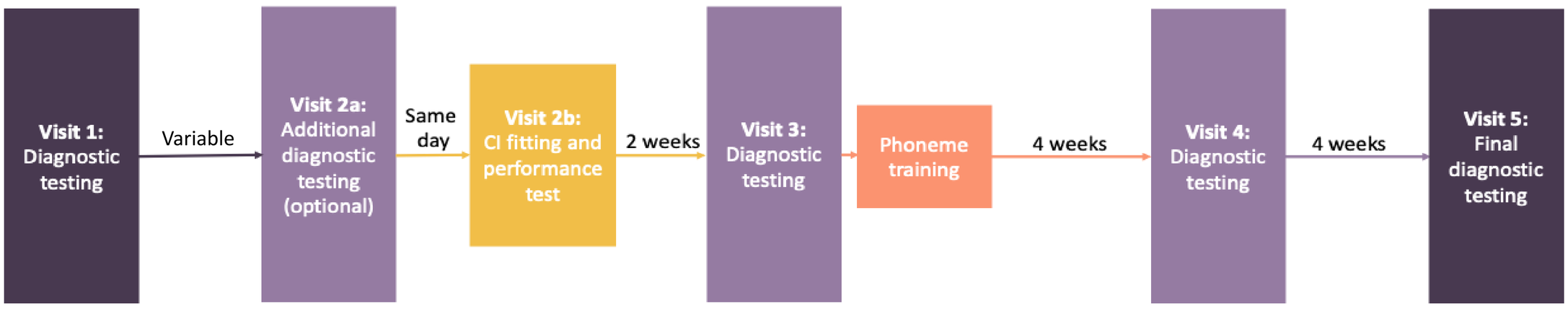

Fig. 3 *Timeline for subjects in AuDiET*

The **AuDiET** study aims at providing a proof of concept for individualized interventions.

During **Visit 1** each subject first undergoes a battery of tests so that their unique error profile can be collected. These tests include:

- Tone Audiometry
- Spectrotemporal Assessment
- Phoneme in Quiet tests
- Consonant-Vowel-Consonant Words in Quiet tests
- Digits in Noise tests

Based on the results of these tests and the current fitting profile, a **Fitting Intervention** is drafted by two experienced audiologists. This intervention modifies the fitting parameters in order to address their most common errors.

During **Visit 2** this intervention is loaded onto each subject's processor.

During **Visit 3** the subjects are tested again in order to evaluate the effects of the Fitting Intervention.
Additionally, during the visit the subjects are given a mobile application which will provide them with personalized training exercises focusing on their most common errors. This is the **Training Intervention**.

During **Visit 4** the tests are repeated in order to evaluate the effectiveness of the Training Intervention.

During **Visit 5** the subjects are tested again, in order to evaluate whether the subjects retain any change in speech recognition when not actively training.

Should fitting prove impactful, the relationship between changes to fitting and speech recognition will be investigated in detail, with the aim to move towards **evidence-driven, targeted fitting strategies** to form the basis of **standardised clinical practices**.

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[1] Vaerenberg, B. *et al.* (2014). Cochlear implant programming: a global survey on the state of the art. *The Scientific World Journal*, *2014*, 501738