Investigating the impact of hearing-aid processing strategies on hierarchical speech processing

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INTRODUCTION

- Listening to a speaker **in noisy multi-talker scenarios** is a complex source separation operation, guided by behavioural goals.
- Previous studies showed that cortical signals track the acoustic envelope of a speech input [1]. In multi-talker scenarios, stronger cortical tracking was measured for Attended than Unattended speakers [2].
- Speech listening is challenging for **hearing-impaired listeners** in noisy, multi-talker scenarios, even when using hearing aids.
- **Noise Reduction (NR) schemes** of hearing aids enhance the cortical representation of the whole acoustic scene, with an improvement driven by a better neural representation of the attended speaker [3].
- Yet, it remains unclear which stages of the speech processing hierarchy are specifically affected by NR schemes and focus of attention.
- This study thus investigates the impact of NR schemes and focus of attention on **acoustic and phonemic processing**.

METHODS

EEG experiment

34 participants (mean age 64.2, SD 13.6).

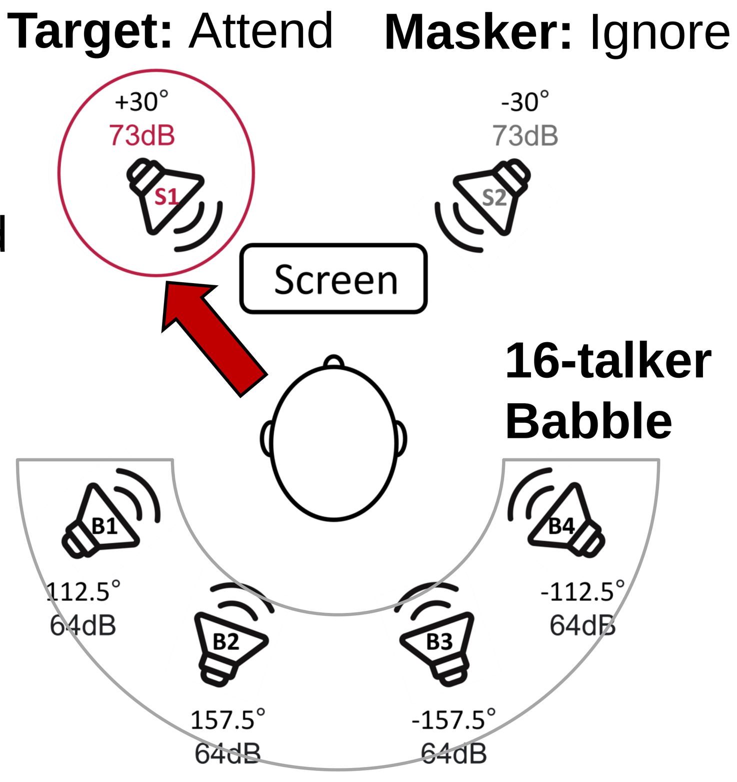
Mild to moderately severe symmetrical **HL**. Amplification through Voiced Aligned Compression.

20 Danish short clips per block (2 blocks, 20 minutes each).

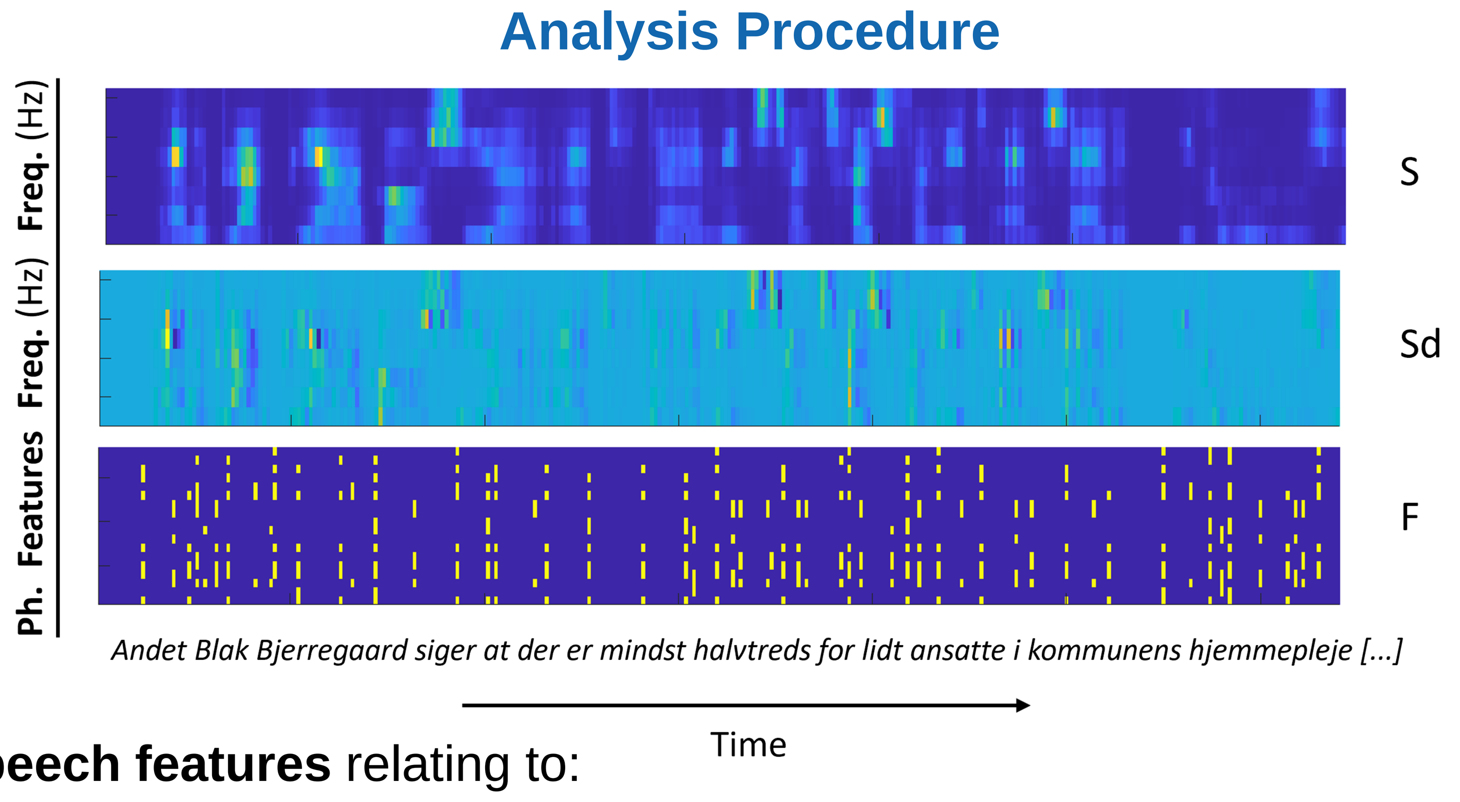
64-channel **EEG**

Conditions: NR On and NR Off.

Target: Attend **Masker:** Ignore



Analysis Procedure



- **Speech features** relating to:
  a) Acoustics: Spectrogram (**S**) and Spectrogram Derivative (**Sd**).
  b) Phonetics: Phonetic Features (**F**).
- Features used as regressors in a multiple linear encoding model - Temporal response functions (TRFs) - in order to predict EEG data.

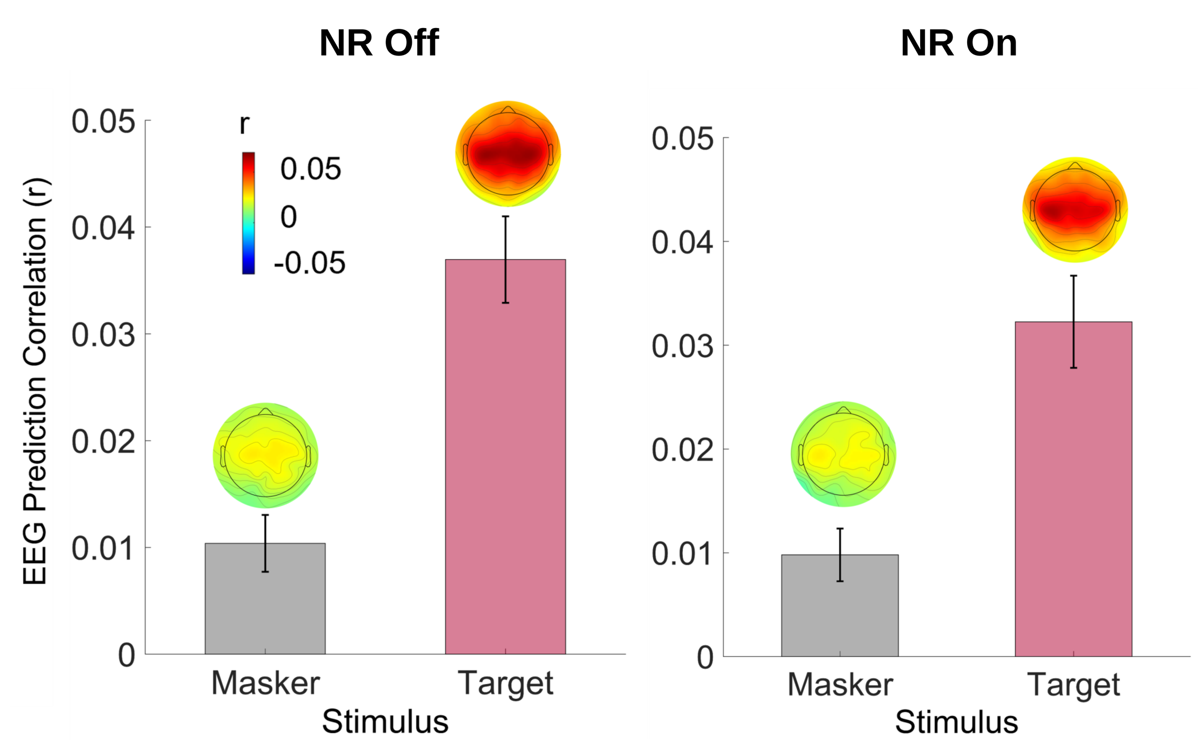
Hypotheses

- Target speaker > Masker speaker
- Higher EEG prediction correlations for the frontal speakers (Target and Masker) with Noise Reduction scheme turned on.
- A + F Model improves EEG reconstruction accuracy for Target, but not for Masker.

RESULTS

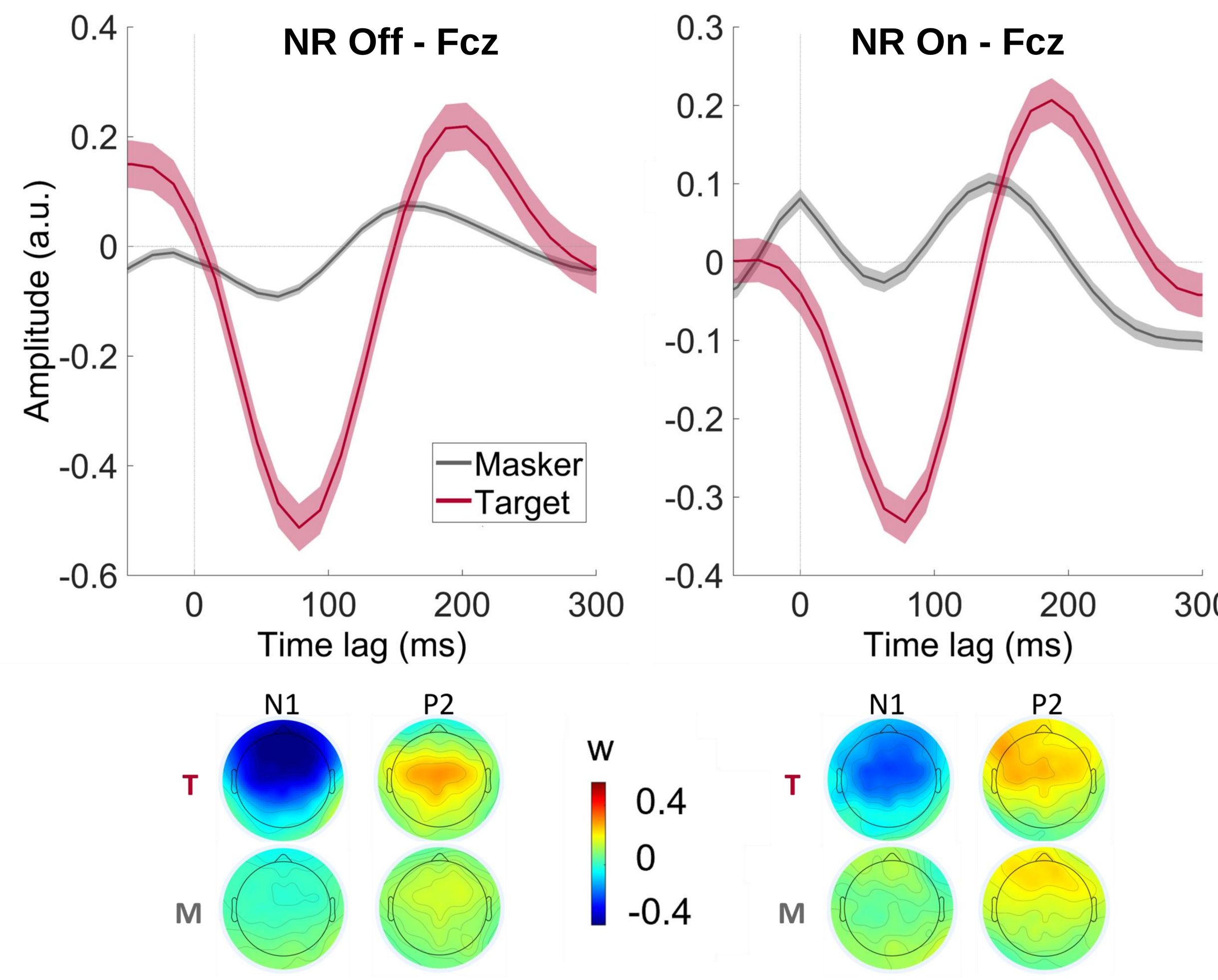
Acoustics EEG Prediction Correlations

- Masker speaker's acoustics suppressed.
- Central electrodes are highly predictive.
- Left-hemisphere shift from NR Off to NR On.

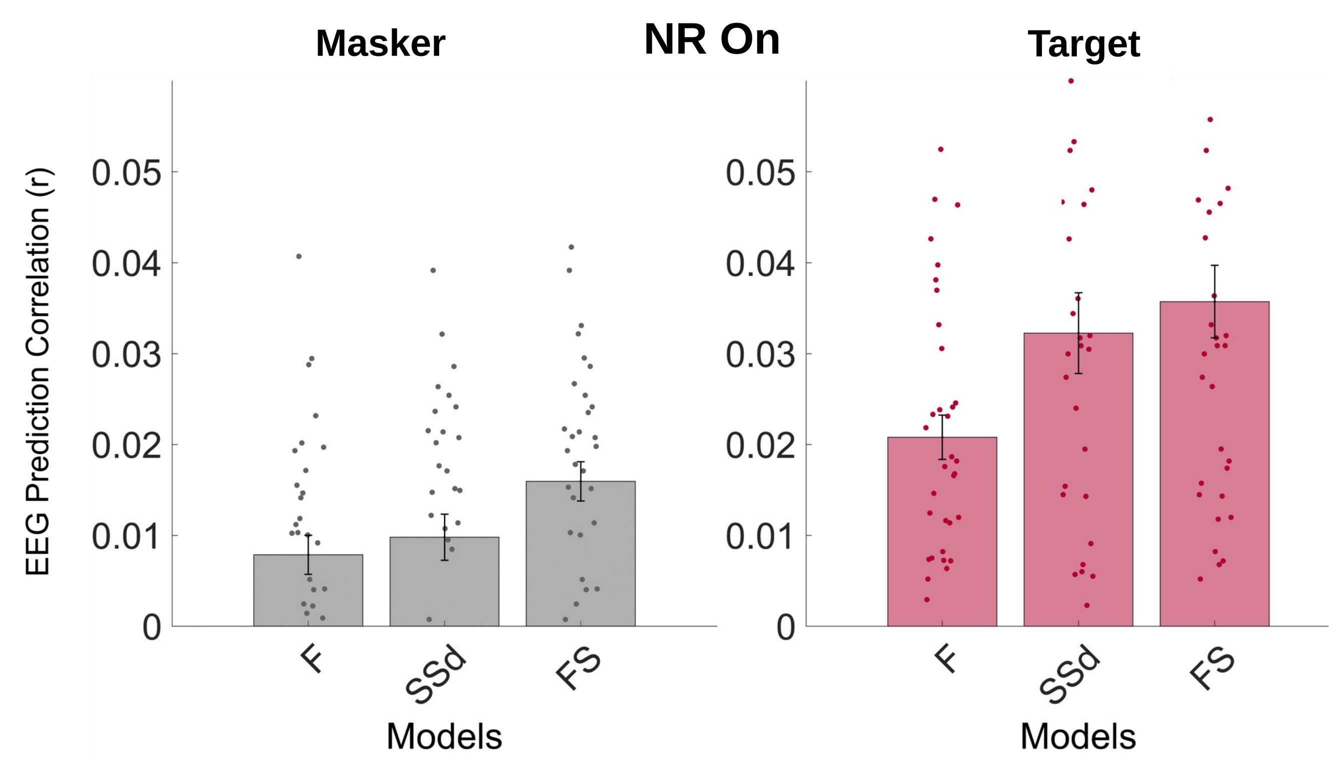


RESULTS

Acoustics TRF (S and Sd)



Model Comparisons – Acoustics and Phonetic Features (FS)

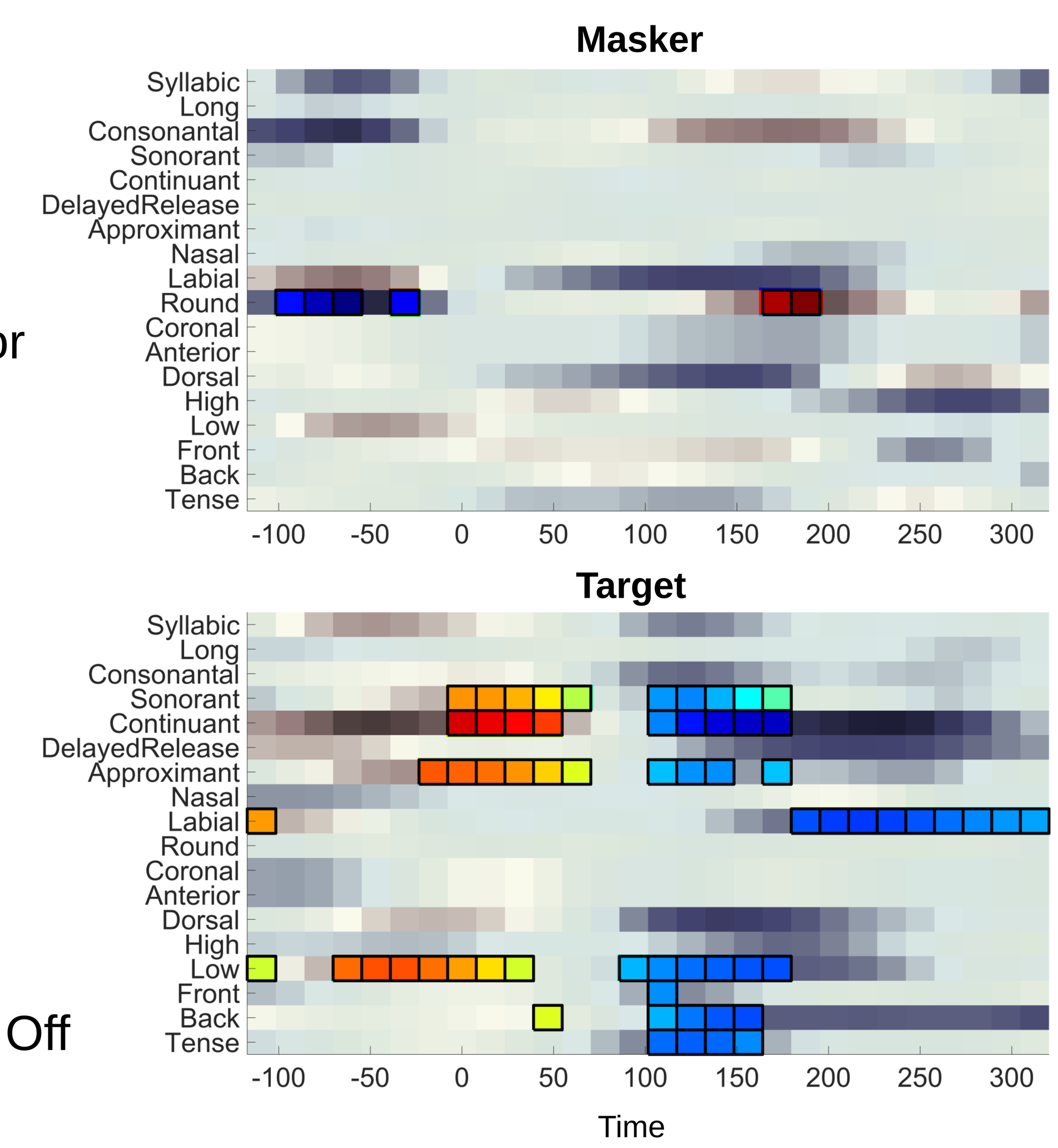


- The addition of Phonetic Feature onsets (F) to the Acoustics-only model (SSd) increases prediction correlations not only for the Target talker, as expected, but also for the Masker.

TRF Phon. Features weights for FS Model

- Despite the contribution of Phonetic Features for both Target and Masker stimuli, the Target stimulus displays a higher number of phonetic features with significant and more typically distributed TRF weights [4].

Similar results were obtained for the NR Off condition.



DISCUSSION

- Neural representation of the Target speaker enhanced compared to the Masker's, in both NR conditions.
- NR Off yields a better EEG reconstruction performance than NR On: potential acoustic effect due to the background noise?
- Phonetic Features represented for ignored speaker as well: missing acoustic features in the model or an unexplored (compensatory) listening strategy?

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