

Trial-by-Trial Analysis of Phoneme-in-Noise Perception using a Model of Monaural Auditory Processing

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Context: Bridging experimental results with simulations

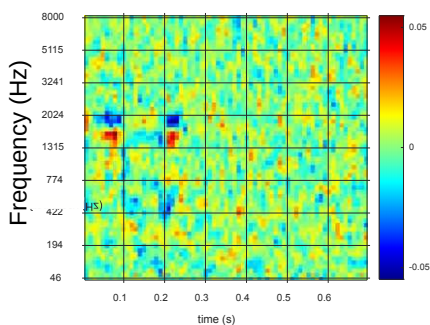
- Speech-in-noise paradigm: Auditory Classification Image (ACI) method (Varnet et al. 2013, 2015a, 2015b)
- We are in process of optimising this method benefiting from auditory modelling

From Léo's presentation:

Classic revcorr analysis

[Ahumada & Lovell, 1971]

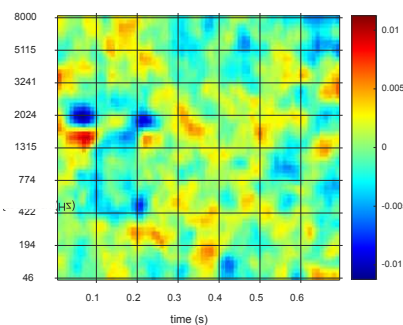
N = 10 000 trials (≈8h)



Ridge regression

[Varnet et al., 2015, 2016...]

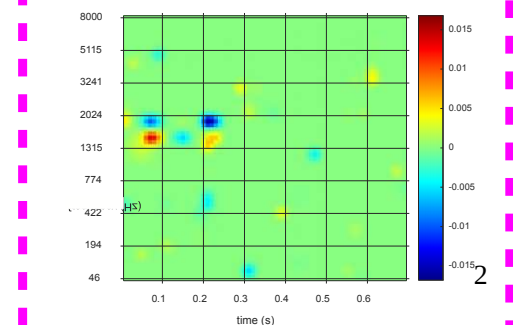
N = 5000 trials (≈4h)



Lasso on Gaussian pyramid

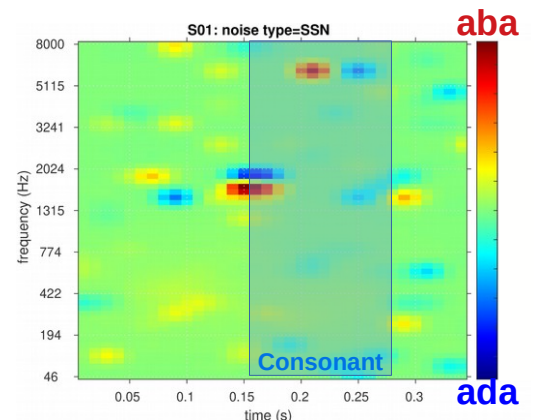
[Osses & Varnet, 2021]

N = 3000 trials (≈2,5h)



Phoneme discrimination using the ACI method

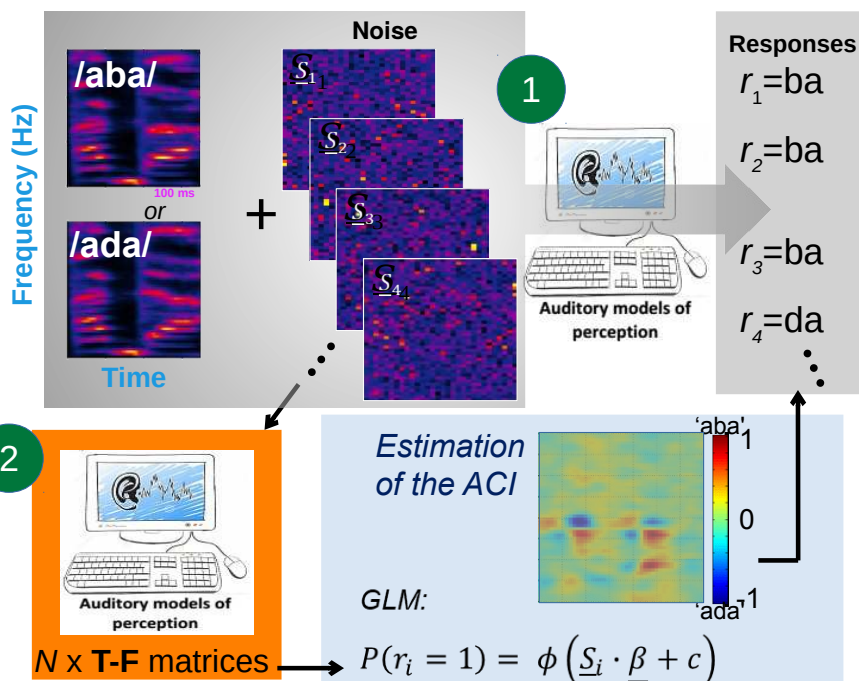
- Experimental data on two participants (S01, S02), 5000 trials
 - SSN: data from Osses & Varnet (2021, DAGA)
 - White noise: S01, data from Varnet et al (2013); S02, new data.
- New data processing and simulation data
- 5000 noises for each condition (total of 10k)
- Same set of noises for S01, S02, and the artificial listener



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Phoneme discrimination using the ACI method

- The reverse correlation method allows to experimentally assess the cues that are relevant in a discrimination task: ACIs



Experimental design:

- Noise fixed, variable speech level
- 1-up, 1-down weighted procedure (Kaernbach, 1991) to track 70.7% correct responses: down step = 1 dB, up step = 2.4 dB
- Little level roving of ± 2.5 dB

Before: transformed up-down (Levitt, 1971)

Before: No roving

Participant's response

	'ba'	'da'
Presented 'ba' ("target")	Hit	Miss
Presented 'da' ("no target")	False Alarm	Correct Rejection

ACI is built from $(H+FA) - (M+CR)$

"target" present: $H - M$

"target" absent: $CR - FA$

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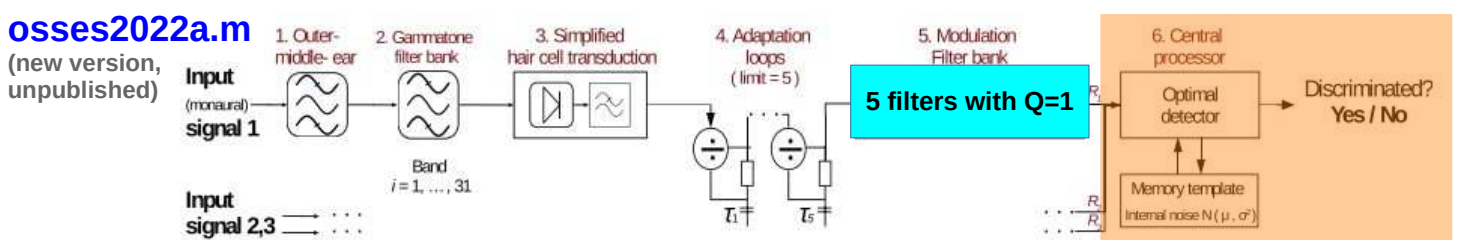
Phoneme discrimination using the ACI method

- Related to **1** :
 - Mimic the human listener strategy
 - How much of an ACI can we explain with an auditory model?
- Related to **2** :
 - “**Target-present**” (ba) and “**target-absent**” (da) analysis using an auditory model?

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Context: Bridging experimental results with simulations

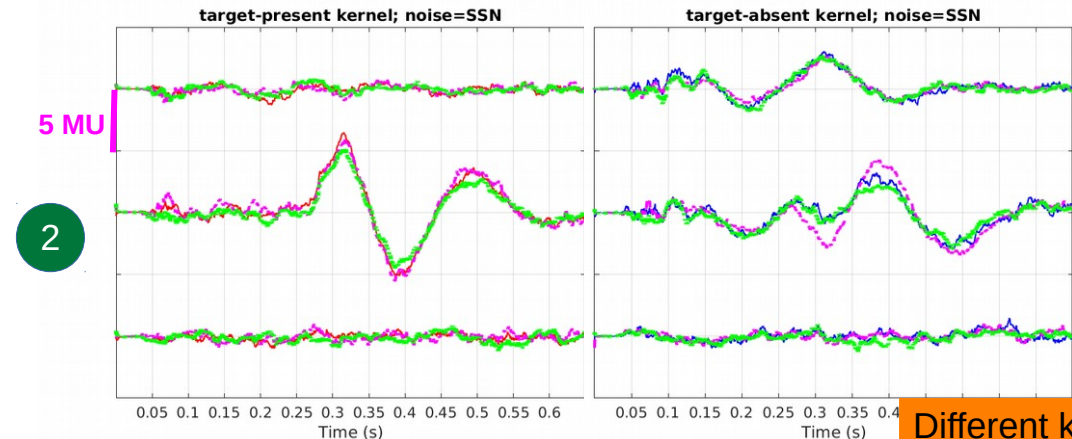
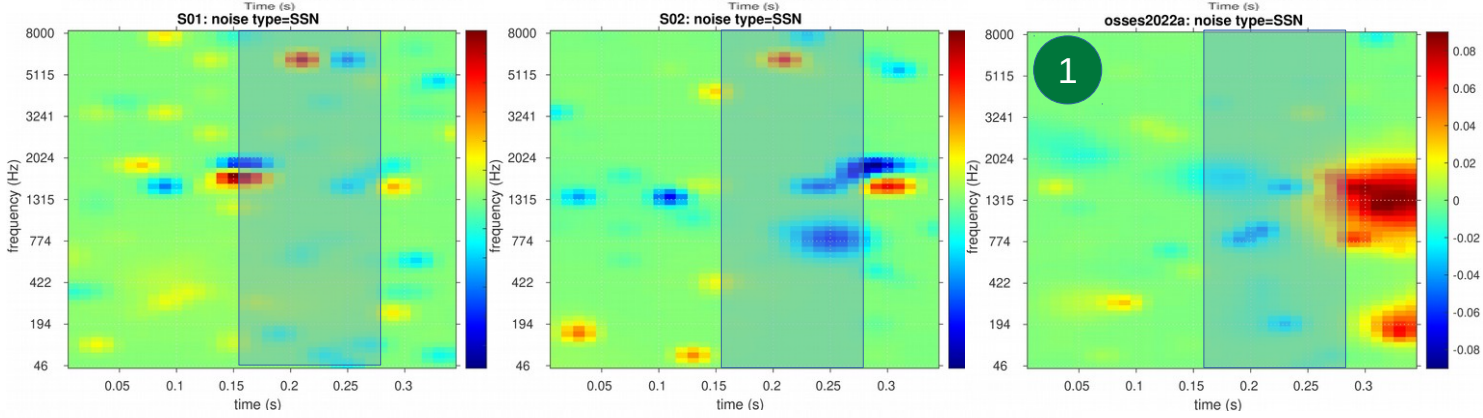
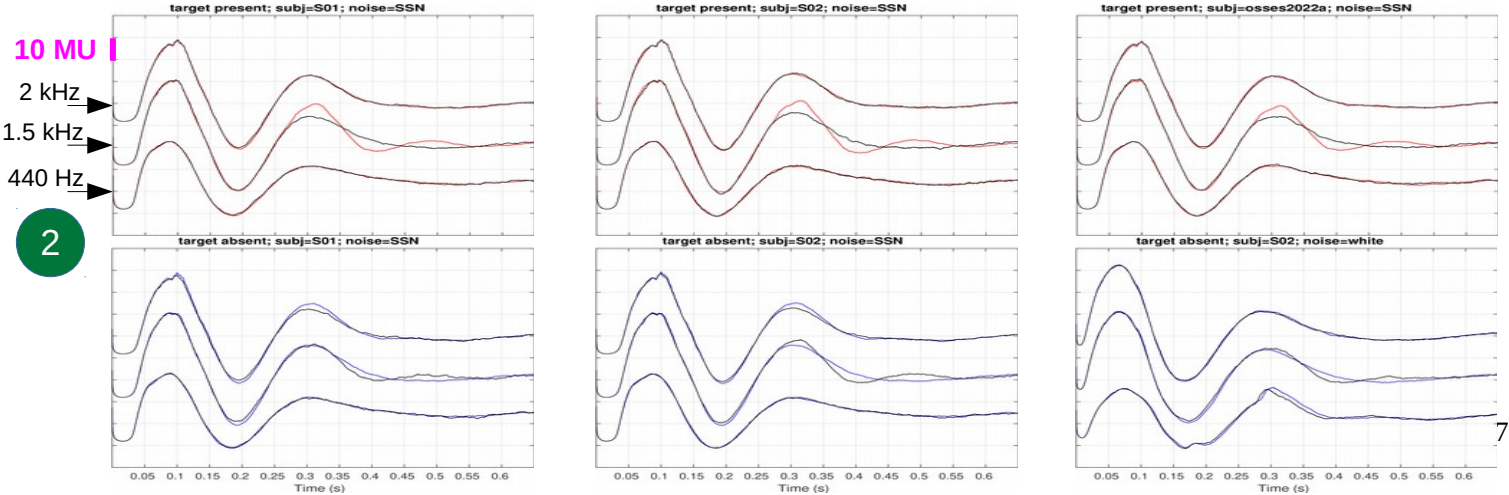
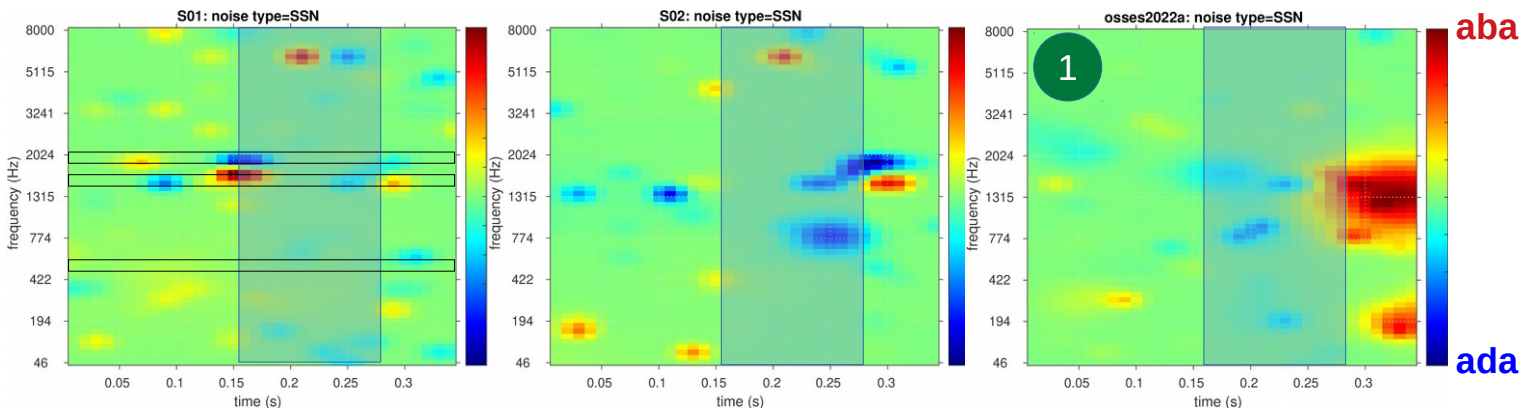
- We chose one auditory model based on Dau et al. (1997) with customised parameters
- We attached the cross-correlator with two templates (Osses & Kohlrausch, 2021) at zero-lag:



The previous `osses2021.m` has a modulation filter bank with 12 filters and $Q = 2$



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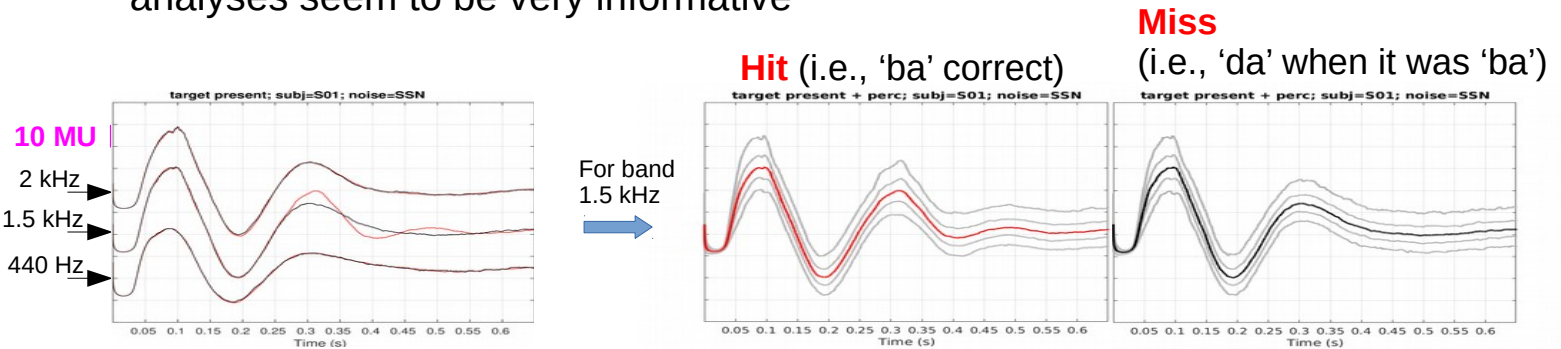


S01 in red/blue
 S02 in magenta
 Model in green

Different kernels for different participants:
 Still using the same auditory model

But, can we rely on the auditory model?

- So far:
 - The auditory model shows that obtained ACIs are the result of the noise fluctuations
 - Not only the ACIs but also the target-present (aba) and target-absent (ada) analyses seem to be very informative



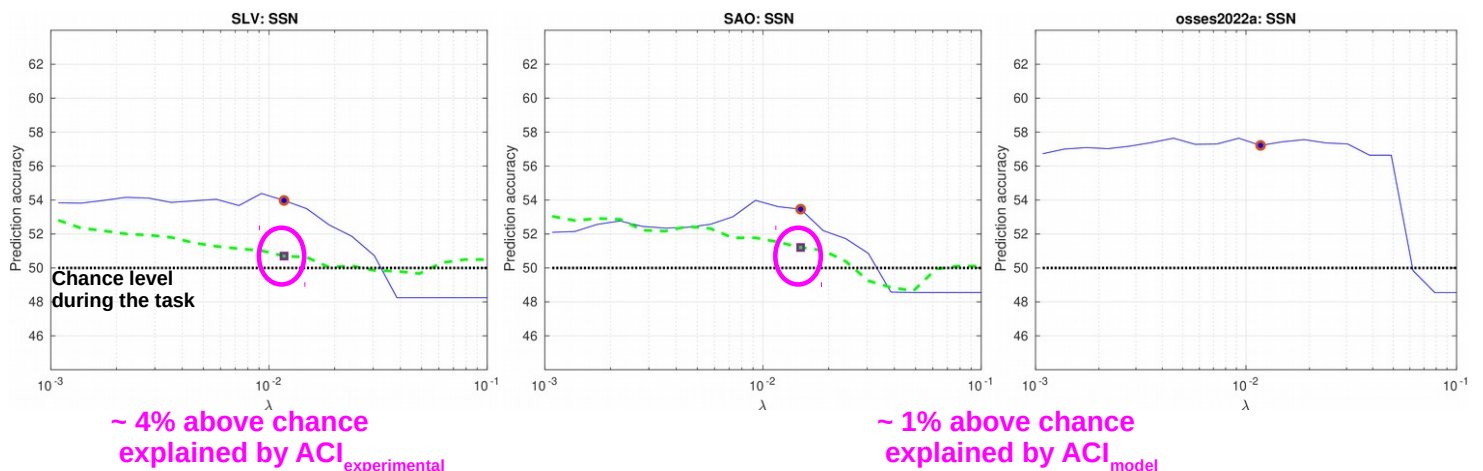
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But, can we rely on the auditory model?

- But, can we rely on it?
- Prediction accuracy (PA): How much % of the participant responses I can predict?

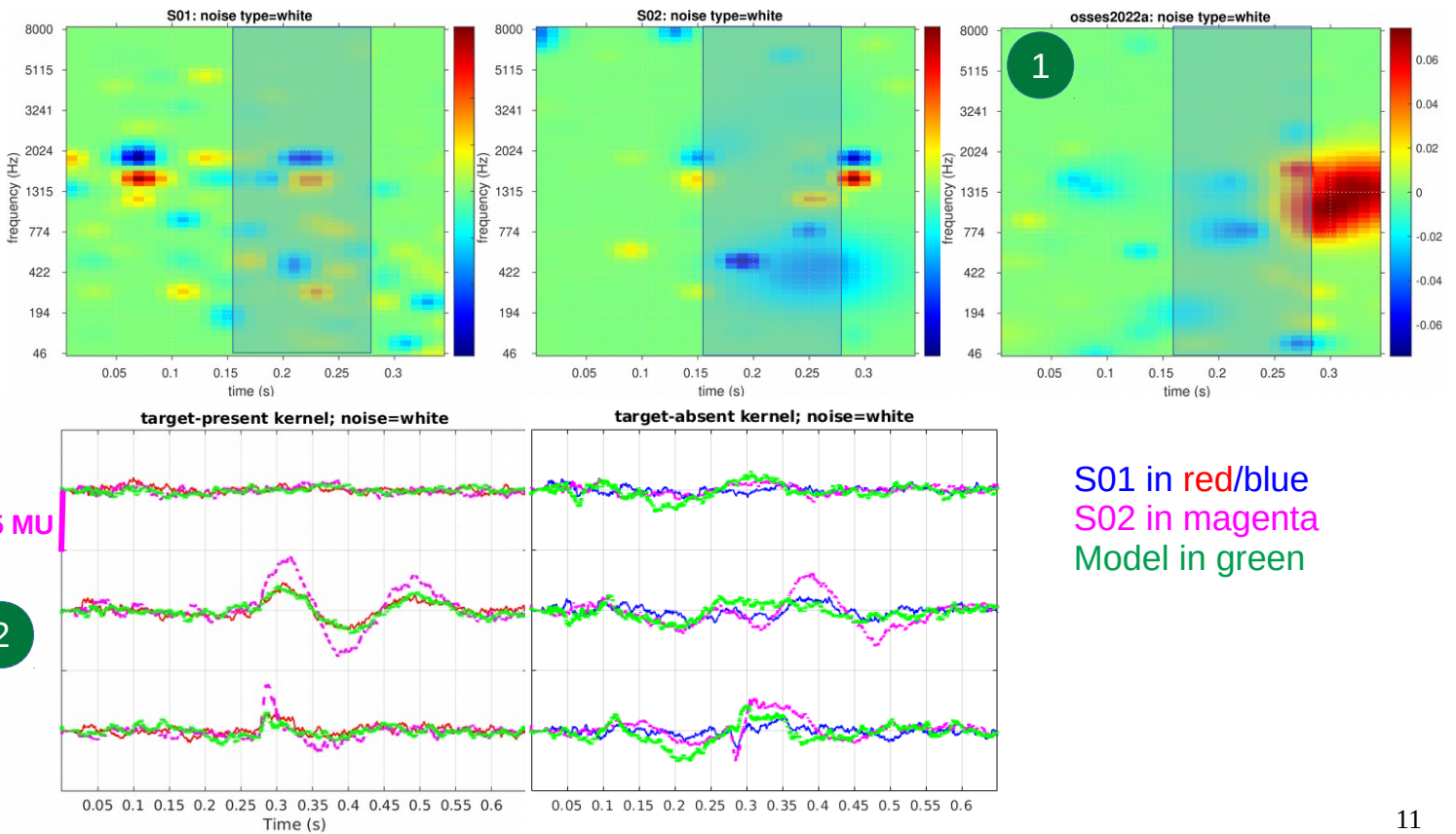
PA with own ACI

Cross-prediction with ACI_{model}



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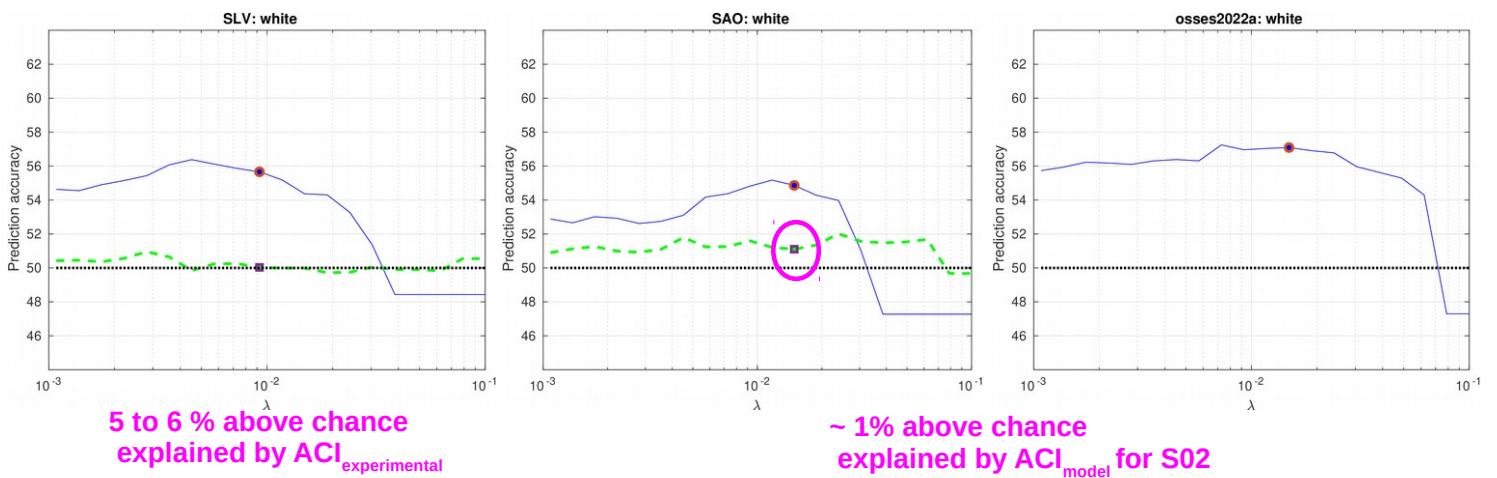
The same analysis for another supra-threshold condition: white noise...



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Prediction accuracy for the white noise

PA with own ACI
Cross-prediction with ACI_{model}



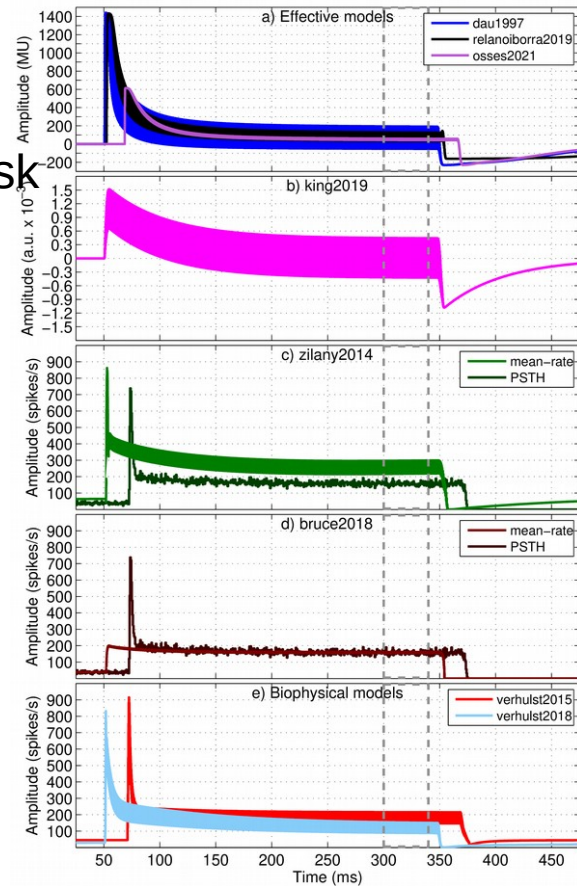
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Summary

- Reverse correlation method:
Trial by trial analysis for a supra-threshold task
 - 4-6 % of prediction benefit using ACIs
 - ~1% for cross-prediction using the model
- Between-participant variability:
Many analyses are possible
- Auditory models: Can be strategically used, but a warning:
They can provide very different results

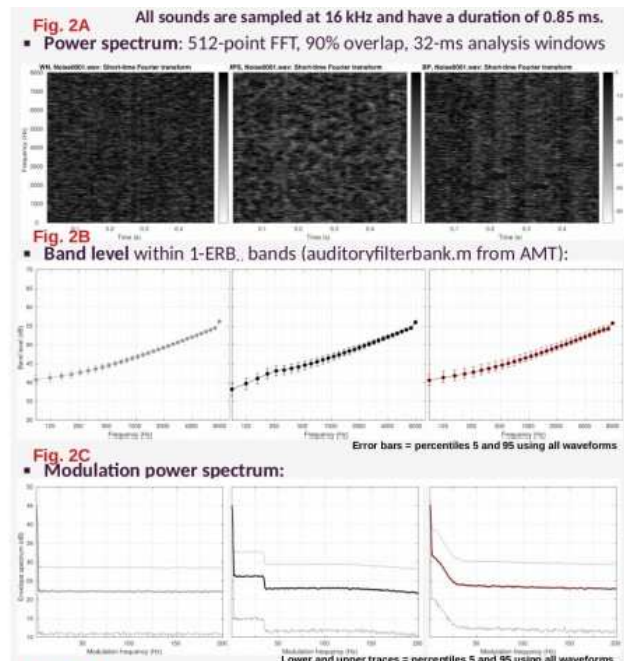
Fig. 10 from Osses, Varnet, Carney, Dau, Bruce, Verhulst, & Majdak (2022, ArXiv)

Fully reproducible figures with AMT 1.1



Further work

- Here: Reverse correlation in “stationary” background noises
- New noises with more envelope variability (visit ARO poster 800)
- Individualise the auditory model:
 - Using a different decision scheme
 - Impaired model
- Have a look at our toolbox:



fastACI toolbox v1.0: a MATLAB toolbox for investigating auditory perception using reverse correlation (<https://github.com/aosses-tue/fastACI>, cf. **ARO poster 800**)

References

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