#EUHA2025

HEAR TO COME & CONNECT & INFORM 69.

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Einfluss von Kompression auf die neuronale Repräsentation von Sprache

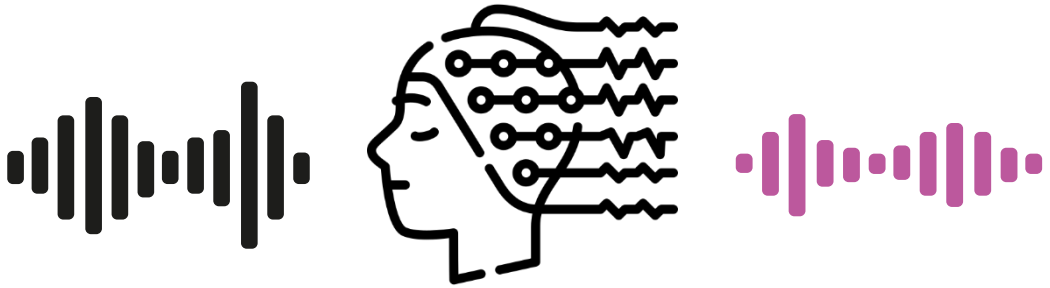
Dr Ronny Hannemann

orcalabs
The Scientific Institute of WS Audiology

Einfluss von Kompression auf die neuronale Repräsentation von Sprache

Increase people's ability to communicate & participate by offering innovative hearing solutions

Summary



Can amplitude compression be used to help hearing-impaired participants in a cocktail party scenario?

Independent compression for distinct speech sources augments neuronal contrast between these sources and support processing of target speech.

the study I talk about today:

Does amplitude compression help or hinder attentional neural speech tracking?

M.Orf, R.Hannemann, J. Obleser in Journal of Neuroscience 2025 (https://www.jneurosci.org/content/45/11/e0238242024.abstract)

Part of joint research projects of ORCA Labs with Dr Martin Orf & Prof Jonas Obleser
Center of Brain, Behavior and Metabolism (CBBM), University of Lübeck, Lübeck, Germany

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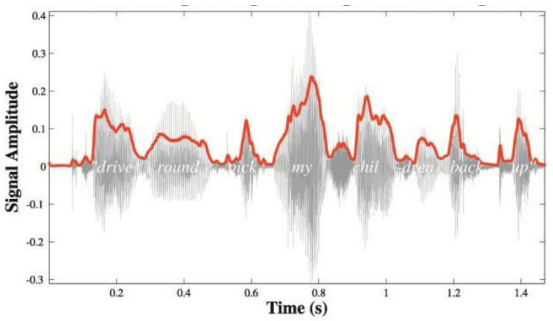
Motivation & Background

Increase people's ability to communicate & participate by offering innovative hearing solutions

Amplitude compression is an indispensable feature in modern hearing aids

Amplitude compression directly affects the envelope of speech, which is crucial for speech comprehension



Neural processing of amplitude compressed speech signals is not well-studied

Figure from Goswami et al 2013

Research Questions

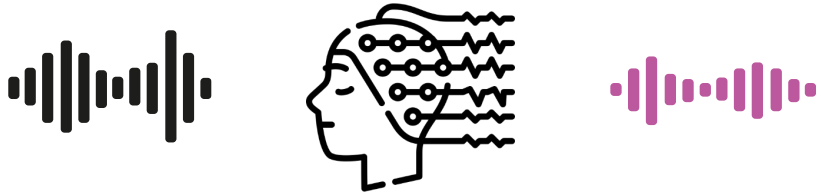
Increase people's ability to communicate & participate by offering innovative hearing solutions

1) Does amplitude compression affect the neural representation of speech?

2) If applied only on one speech stream (out of two), does amplitude compression

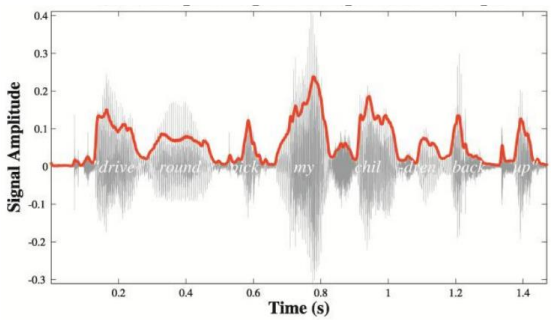
   a) increase the neural separation between both streams?

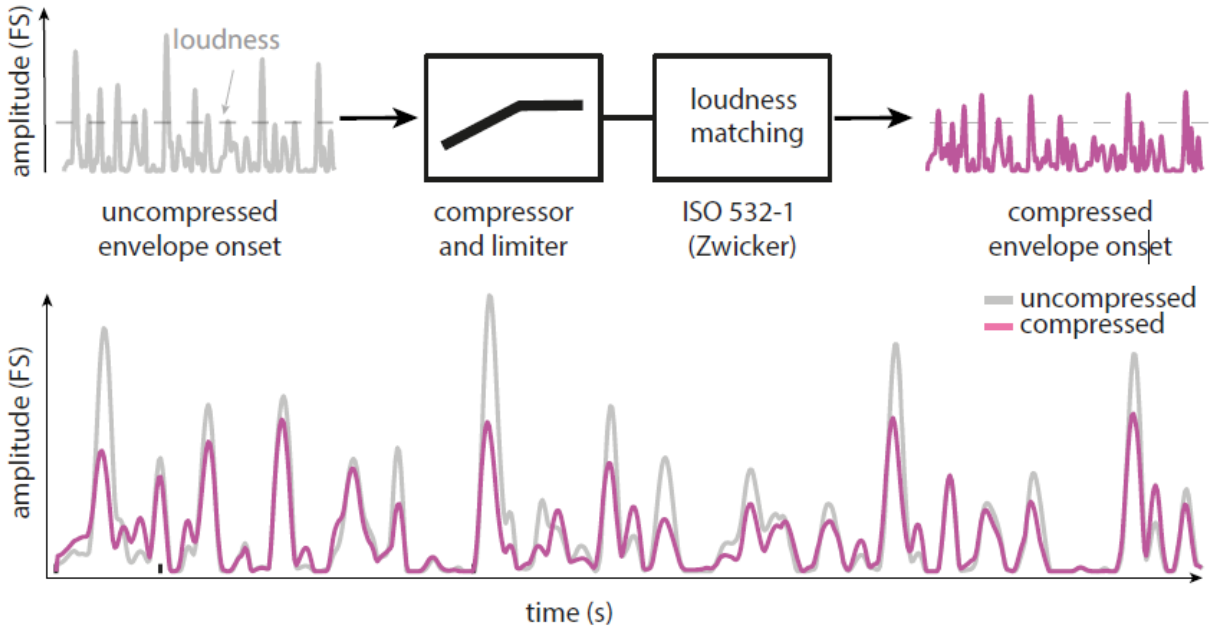
   b) impact also the neural representation of the uncompressed stream?



Experimental Design

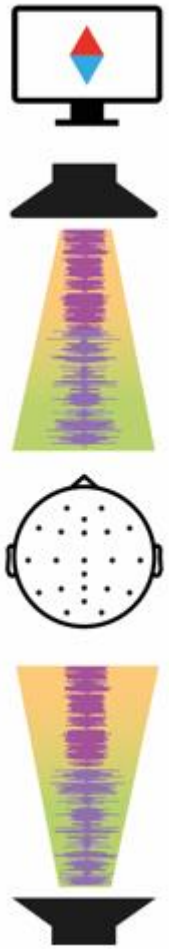
Stimuli: compressed & uncompressed audiobooks

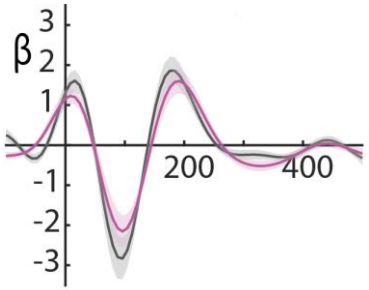




Figures from Goswami et al 2013 and Orf et al 2025

Experimental Design





Stimuli: compressed & uncompressed audiobooks presented simultaneously front and back

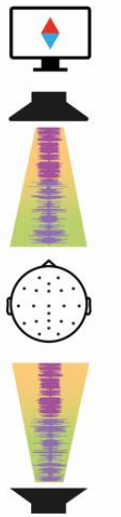
Task: focus on one of two competing talkers and detect short syllable repeats in target talker

Outcome measures:

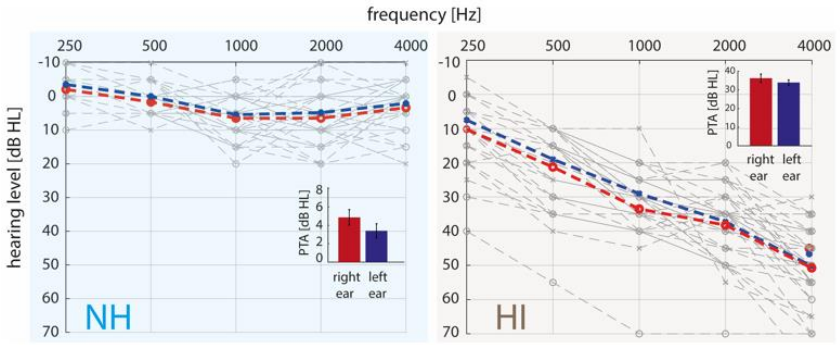
- Participants behavior
- **Neural speech tracking*** = how is the envelope of speech represented in brain activity

* - objective measure differentiating attended speech from concurrently ignored speech (Obleser & Kayser, 2019)
- depend on acoustic signal processing, may serve as an indicator of the benefits of hearing aid algorithms (Petersen, 2022)

Experimental Design - Participants



Compression	Attention: attend	Attention: ignore
compressed	compressed speech attended	compressed speech ignored
uncompressed	uncompressed speech attended	uncompressed speech ignored



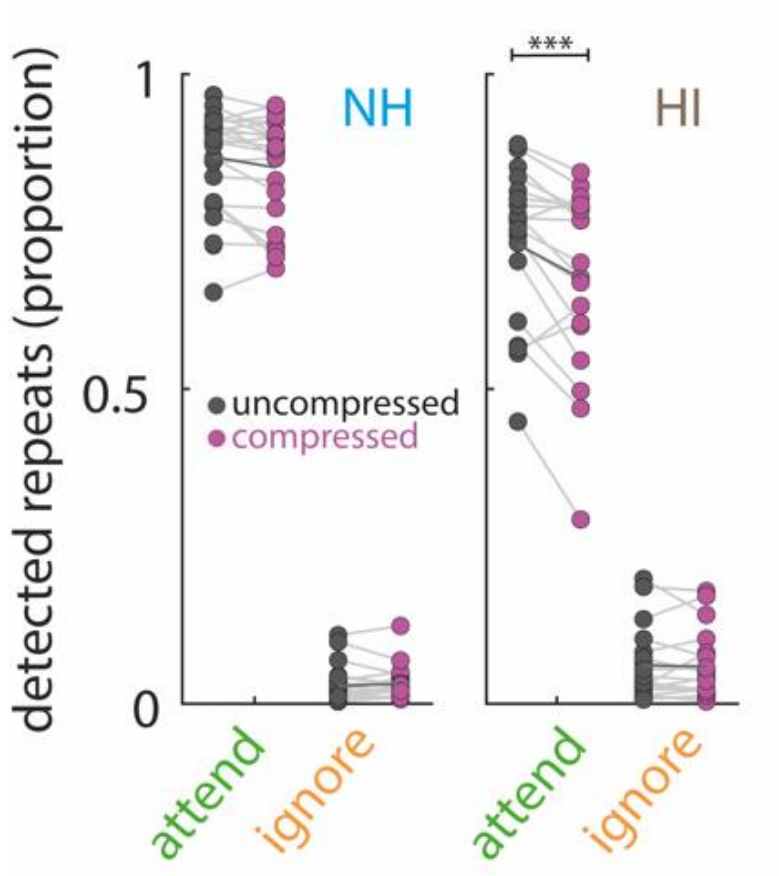
N = 24 Participants without hearing loss
(age: 18-35; PTA < 10 dB HL)

N = 19 Hearing impaired participants
(age: 50-75; PTA > 25 dB HL)

N = 12 Older normal hearing participants
(age: 50-75; PTA < 15 dB HL)

Figures from Orf et al. Journal of Neuroscience 2025

Does amplitude compression affect listening behaviour?

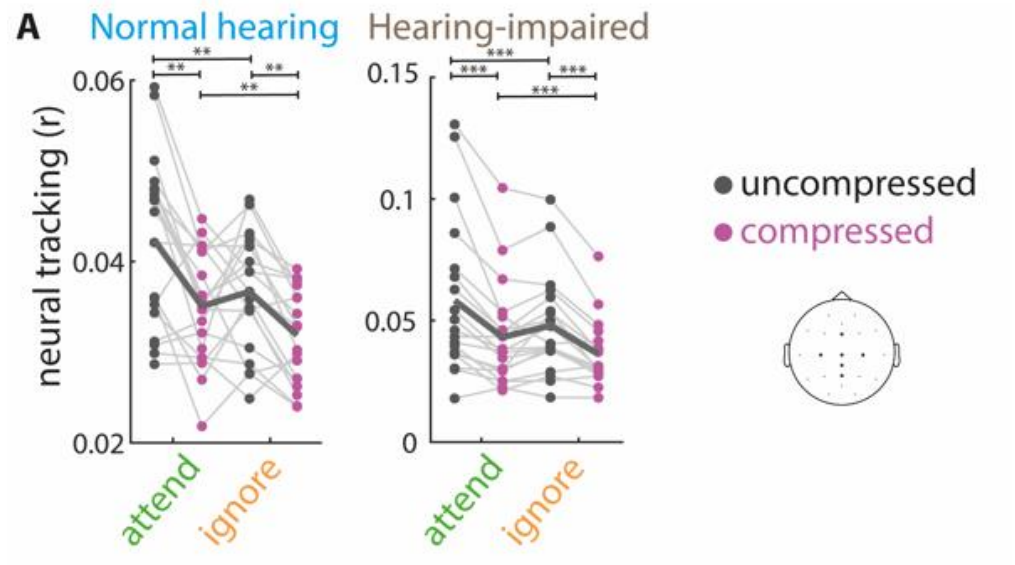


All participants were able to perform the task and attended to the cued audiobook

Hearing-impaired participants showed decreased performance

Figures from Orf et al. Journal of Neuroscience 2025

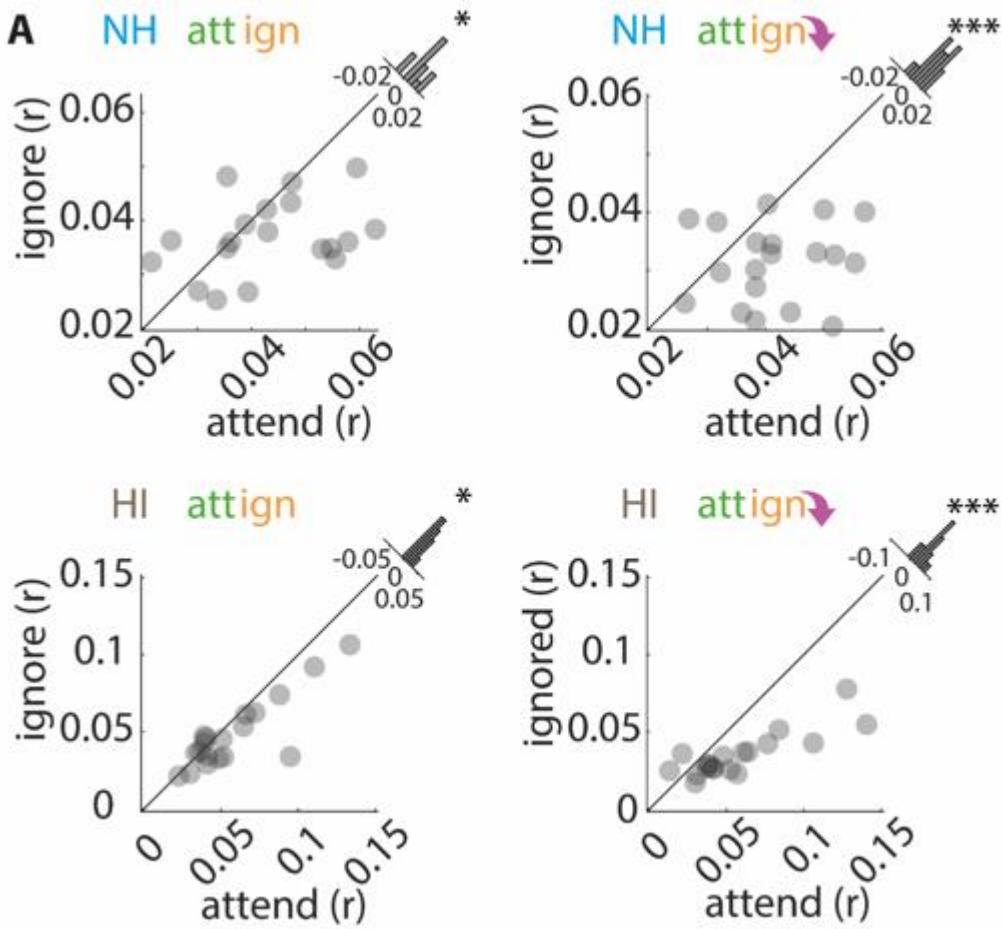
Does amplitude compression affect the neural representation of speech?



Amplitude compression reduces neural responses for both attended and ignored streams in normal and hearing-impaired participants.

Figures from Orf et al. Journal of Neuroscience 2025

If applied only on an ignored speech stream, does amplitude compression increase the **neural separation** between the attended and ignored streams?

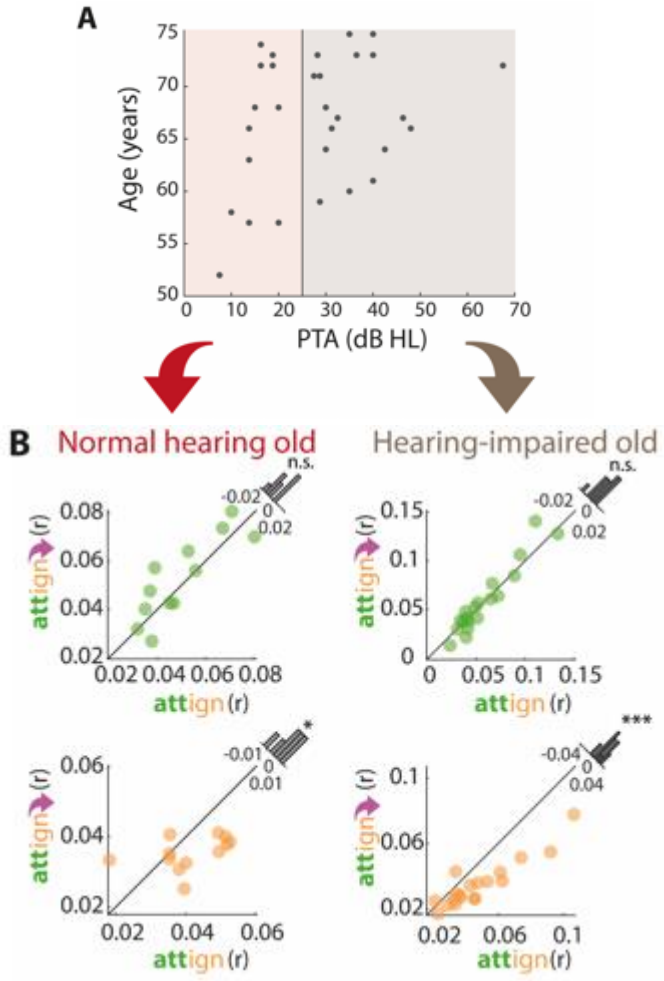


Figures from Orf et al. Journal of Neuroscience 2025

Increased neural contrast between attended and ignored streams if only the ignored stream is compressed.

Larger neural contrast for hearing-impaired participants.

If applied only on an ignored speech stream, does amplitude compression impact the **neural representation** of the attended stream?

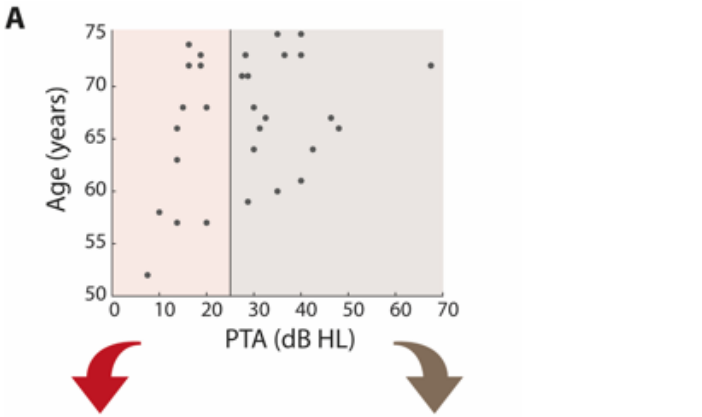


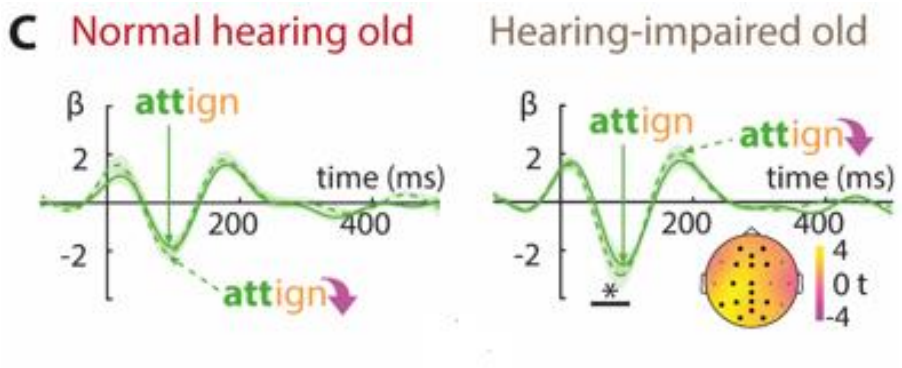
Figures from Orf et al. Journal of Neuroscience 2025

Age-matched comparison between normal-hearing and hearing-impaired older adults:

Larger neural contrast arises from decreased tracking of the compressed ignored stream

If applied only on an ignored speech stream, does amplitude compression impact the **neural representation** of the attended stream?





Age-matched comparison between normal-hearing and hearing-impaired older adults:

Larger neural contrast arises from decreased tracking of the compressed ignored stream

AND **enhanced neural representation of the attended stream for hearing-impaired participants** when the ignored stream is compressed compared to when the ignored stream is uncompressed.

Figures from Orf et al. Journal of Neuroscience 2025

Conclusion – Take home

Increase people's ability to communicate & participate by offering innovative hearing solutions

Summary

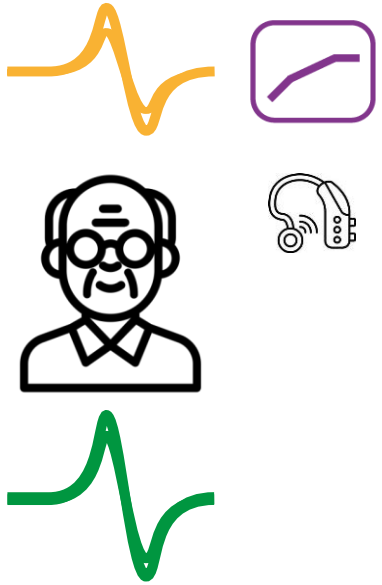
Amplitude compression hampers neural speech tracking

Independent and targeted amplitude compression schemes for different acoustic streams

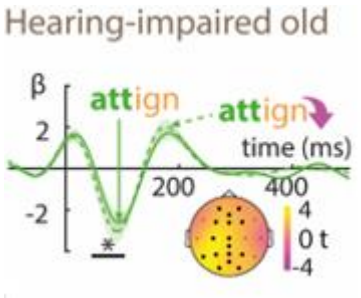
1) Augment neural contrast between speech streams
2) Increase neural representation of target speech for hearing-impaired participants

Thanks for your attention!

Increase people's ability to communicate by offering innovative compression schemes!



→ Hearing aids featuring independent compression for distinct sources could be the preferred choice for enhancing communication in complex environments.



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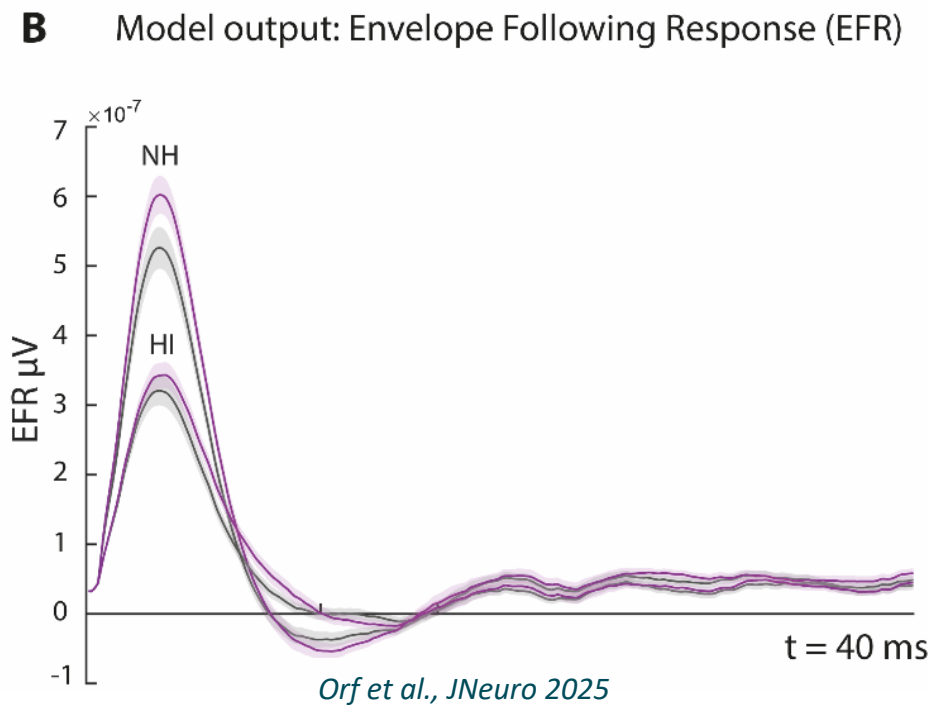
Thanks for your attention

Appendix



Orf et al., JNeuro 2025

Computational model of human auditory periphery by Verhulst et al., 2018

The envelope following response reveals that, if anything, compressed speech is processed more strongly than uncompressed speech.