

Perception of Intentional Prosody in Sensorineural Hearing Loss

*Collabration between ORCA Labs (Lyngø, DK) &
Vanderbilt University Medical Center (USA)*

frederic.marmel@wsa.com

VANDERBILT  UNIVERSITY
MEDICAL CENTER

 **orca**labs
The Scientific Institute of WS Audiology

Project members

Haiping Huang, VUMC

Elizabeth Davis, VUMC

Erin Picou, VUMC

Frederic Marmel, ORCA Labs

Dina Lelic, ORCA Labs

Eric Branda, WSA

Introduction & Motivation

- Studies of **communication difficulties** in sensorineural hearing loss have focused primarily on **speech understanding**
- **Speech prosody** (variations of intonational, rhythmic, and tonal properties within an utterance) serves to communicate intentions and mental states

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- Scope of changes in prosody perception needs to be assessed, to then investigate the impact on quality of life
- *This study*: investigates two use cases of linguistic and paralinguistic prosody
 - **“Social subtext”**: is conversation partner’s intention to be sincere, or sarcastic, or to tease, or are they telling a white lie?
 - **Pragmatic intent**: is conversation partner’s intention, when asking a question, to make an indirect request or is it a genuine question? (e.g., “*can we open the windows?*”)

Study design

Participants & Hearing Aids

- Hearing loss group (experienced hearing aid users, N=21, 71.9 ± 6.8 years)
- Typical hearing group (control group: N=19, 63.2 ± 7.1 years, hearing thresholds < 30 dB @ 500 Hz – 4 kHz)
- Hearing loss group test unaided & aided
- Study hearing aids used rather than own devices to reduce between-participant variability arising from differences in device characteristics and fitting protocols

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Stimuli & Procedure

- 2 closed-set categorization tasks, each using a different corpus of English-speaking stimuli
- Task: judge the intention expressed and rate their confidence in their judgment
- Auditory-visual condition in the “Social subtext” task, to investigate the interplay of hearing loss and visual cues on performance and confidence
- Free-field sound presentation (60 dBA average, natural level variations between emotions retained)

Study design

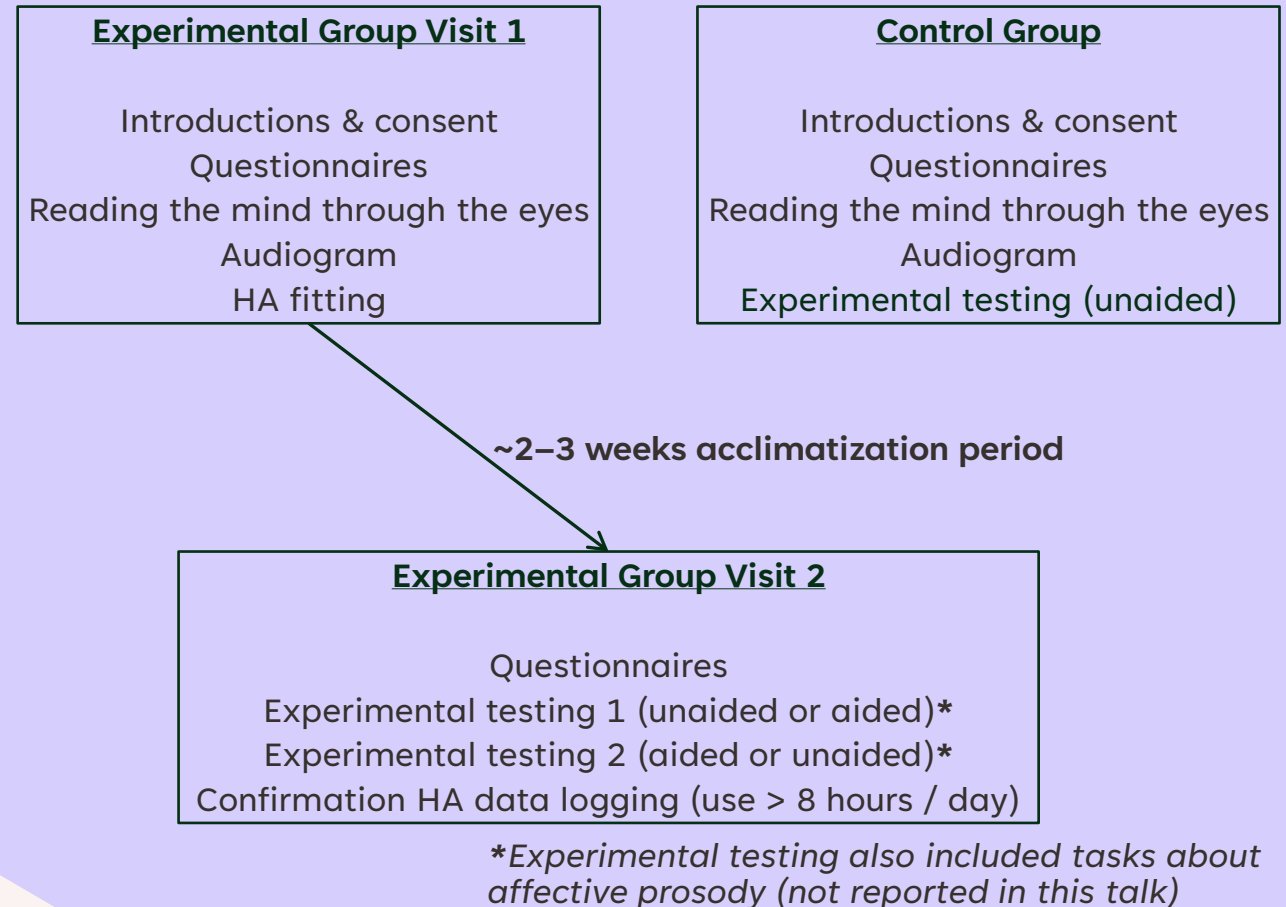
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Study Flow



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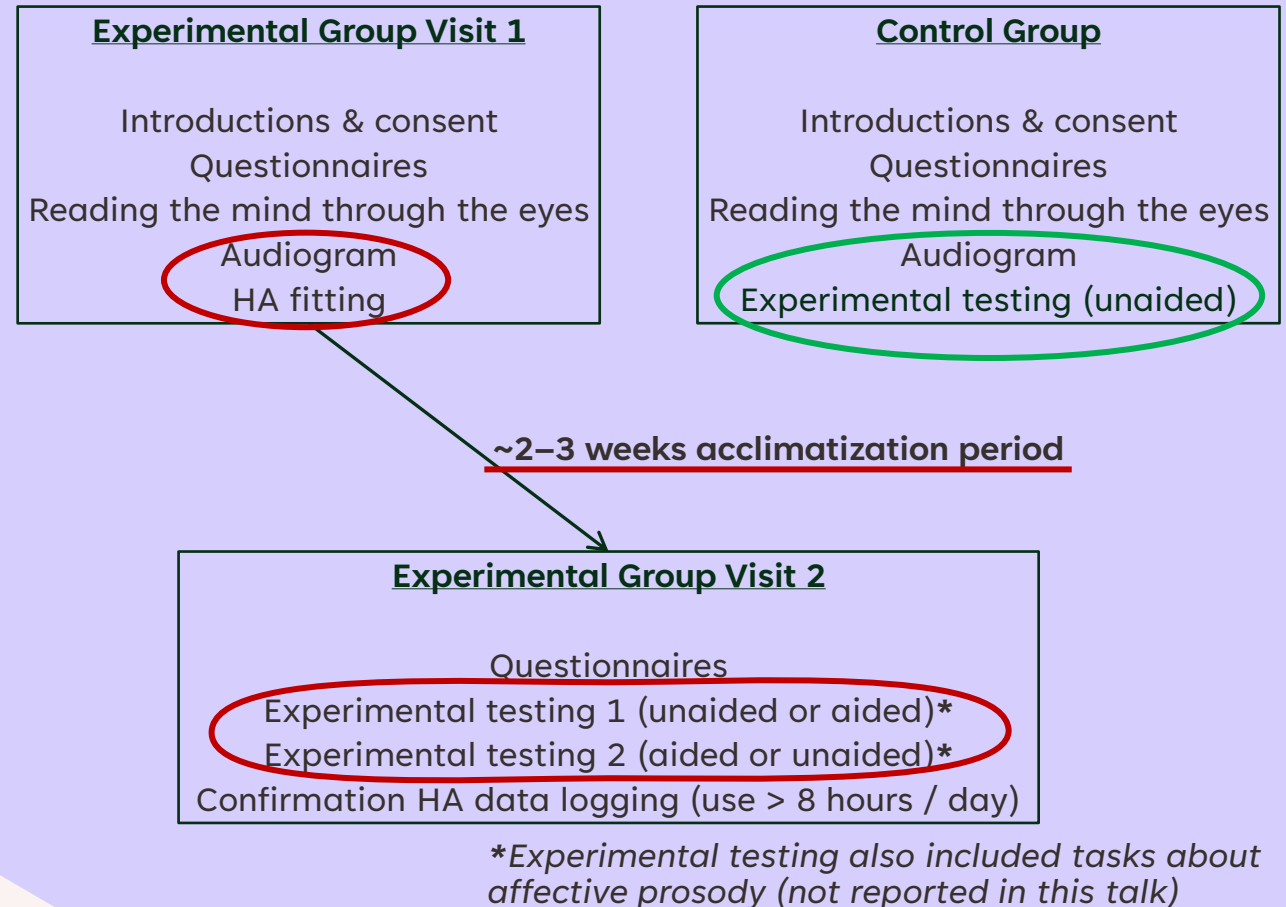
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→ 4 research questions:

- **RQ1.** Are listeners with hearing loss worse at distinguishing between intentions than their peers with typical hearing, and if so, is their performance improved with visual cues?
- **RQ2.** Do hearing aids help with intention perception performance, and do they help more when visual cues are missing?
- **RQ3.** Are listeners with hearing loss less confident when evaluating intentions than their peers with typical hearing, and if so, is their confidence improved with visual cues?
- **RQ4.** Do hearing aids increase confidence, especially when visual cues are missing?

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→ Statistical analyses:

- Linear mixed-effects regression modelling of unbiased hit rates (**RQ1-RQ2**) and of confidence ratings (**RQ3-RQ4**)
- For **RQ1** and **RQ3**, models fit on data from typical hearing and participants with hearing loss *unaided*
- For **RQ2** and **RQ4**, models fit on data from participants with hearing loss, unaided and aided

Intentions – Social subtext

- **Corpus extract:** subset selected from the Relational Inference in Social Communication (RISC; Rothermich & Pell, 2015, PLoS ONE, 10(7))
- Short videos of question-response exchanges between pairs of actors
- Respondent answers with 1 of 4 intentions: be sincere, be sarcastic, tease the asker, or tell a white lie
- Two modalities: auditory-visual (AV) condition and auditory-only (AO) condition created by masking the video
- N trials = 48 / participant

What is the intention of the last speaker?

Be sincere

Be sarcastic

Joke around

Tell a white lie

How confident are you that the person is being sarcastic?

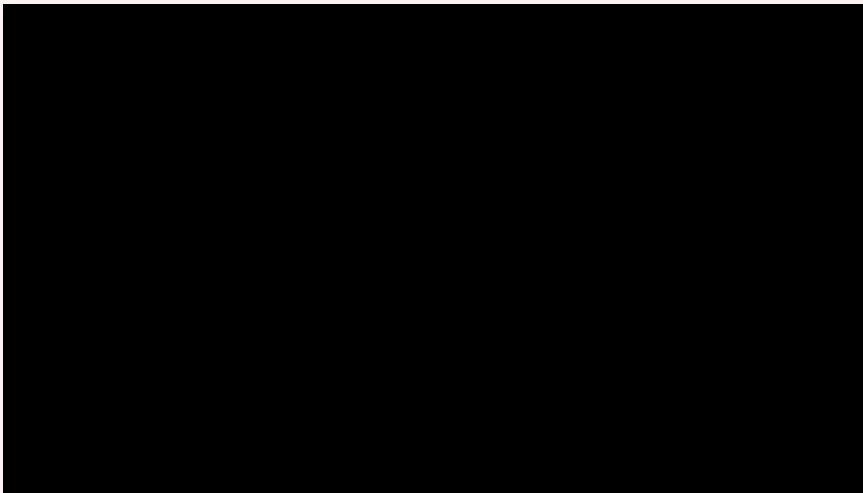
Sarcastic

Not at all

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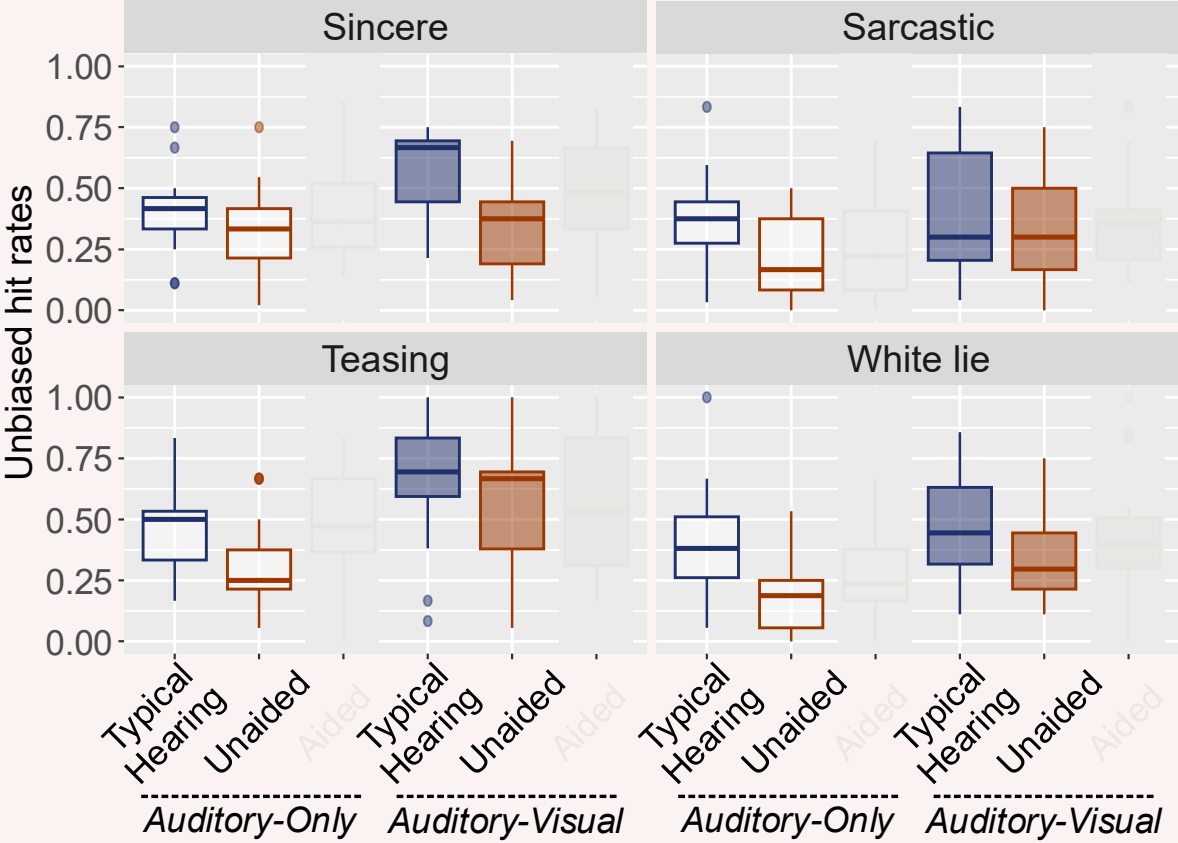
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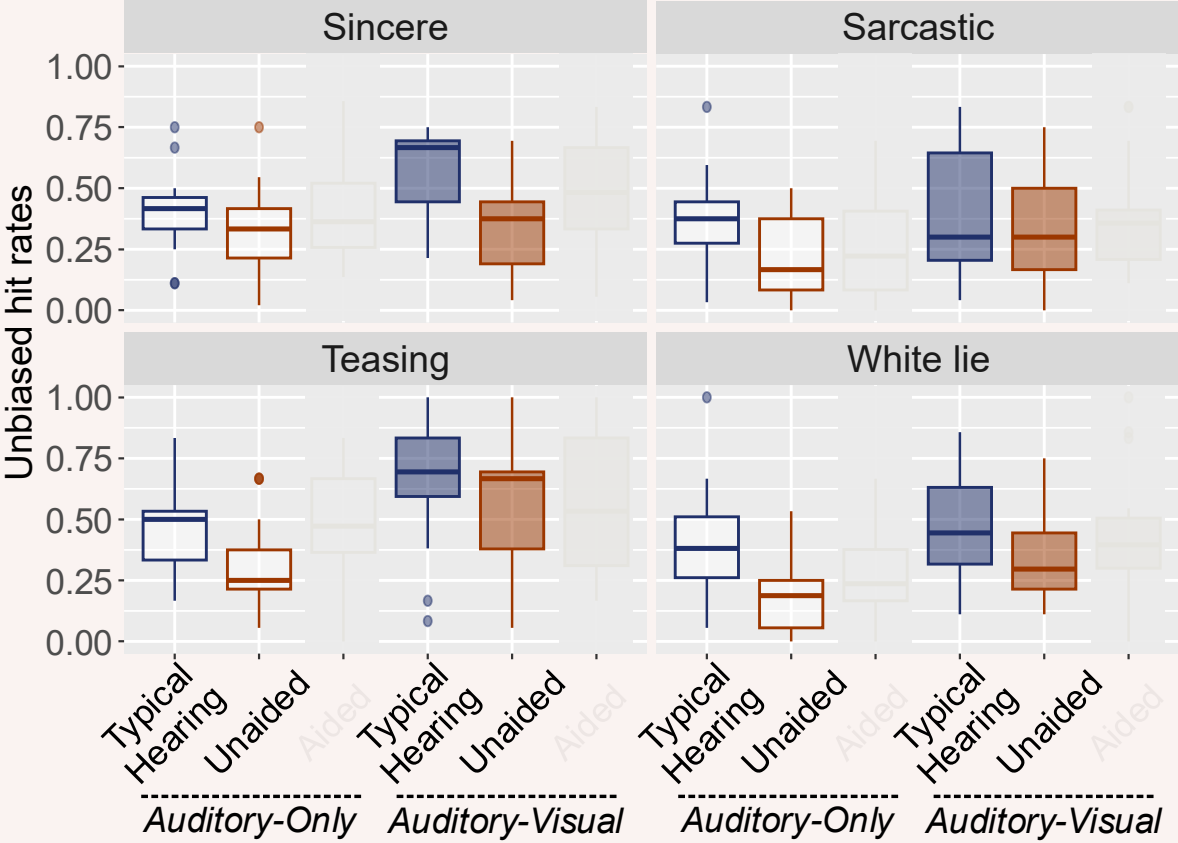
Intentions – Social subtext

Accuracy & Hearing loss

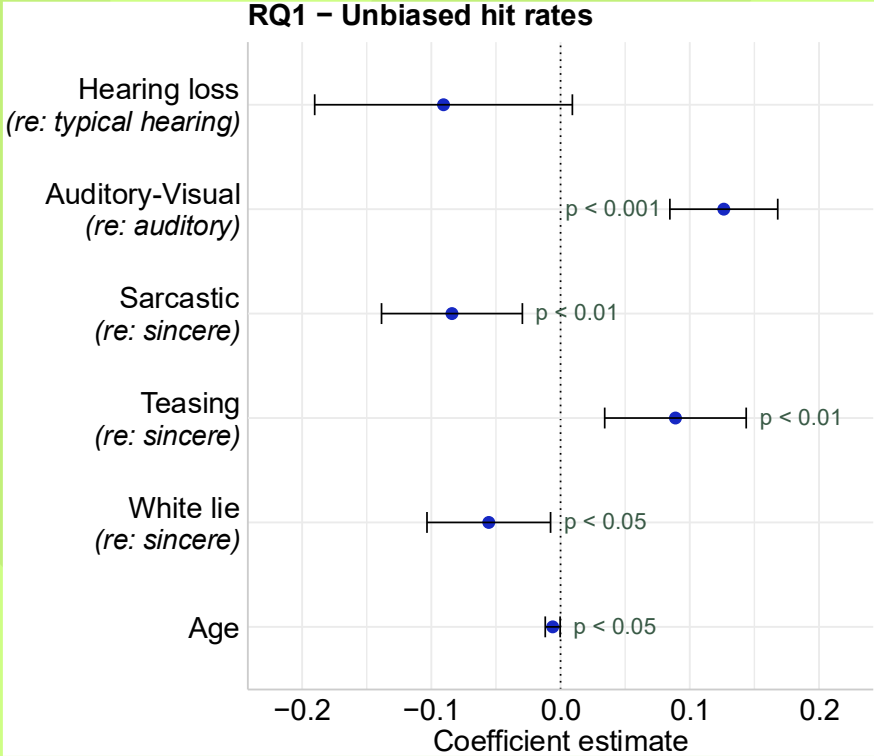


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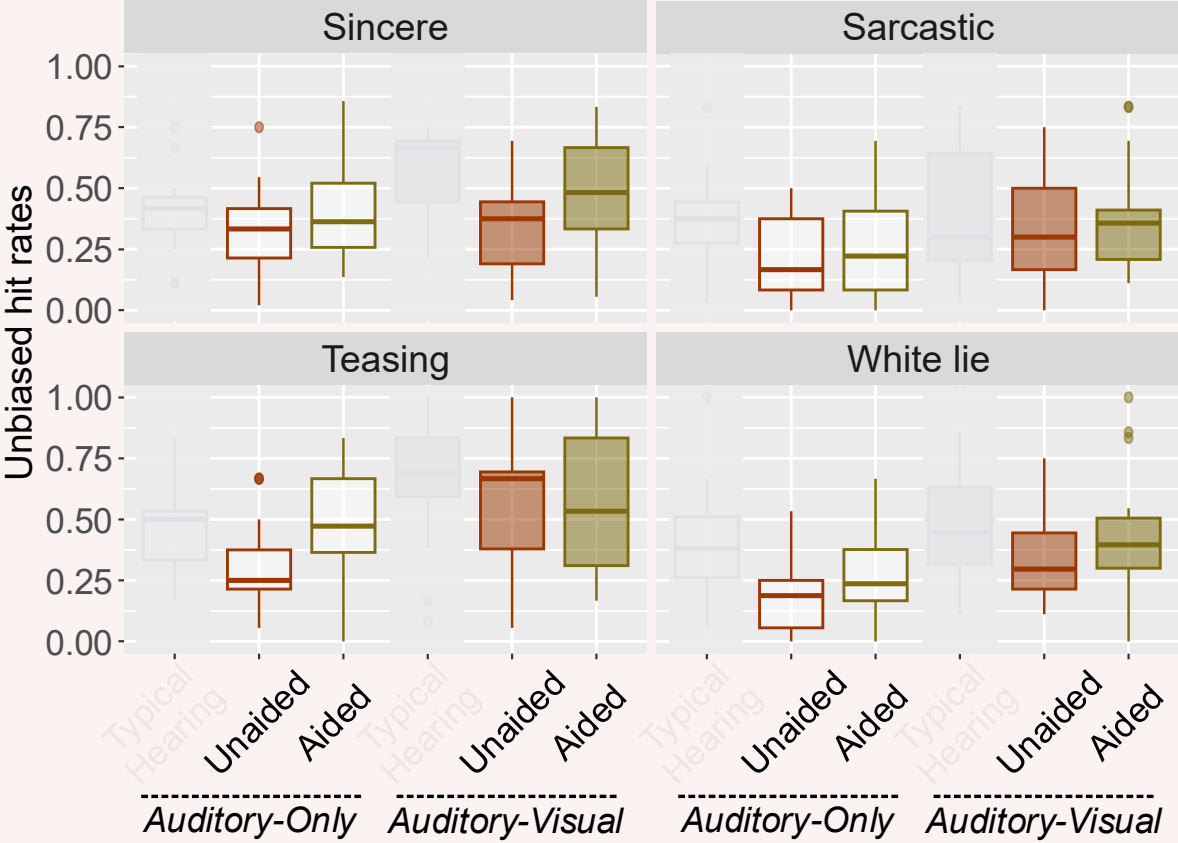


- Visual cues improved accuracy
- Older age was associated with poorer accuracy
- Hearing loss was not significant (*except in alternative model without Age*)



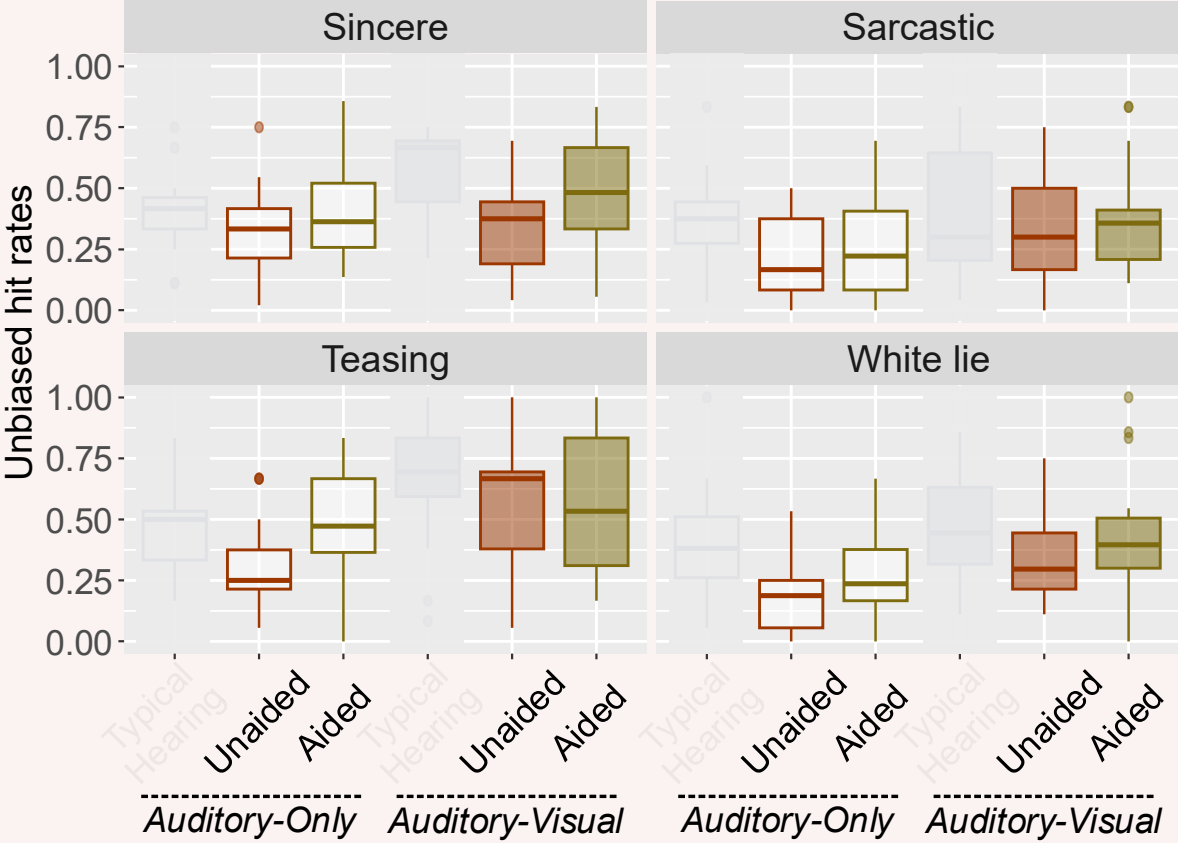
Intentions – Social subtext

Accuracy & Hearing aids

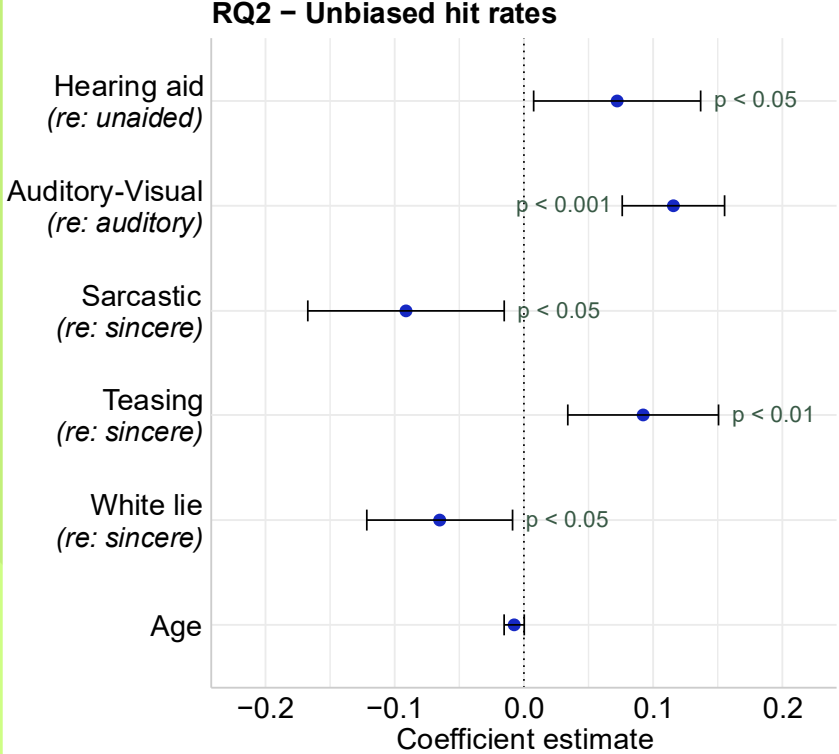


Intentions – Social subtext

Accuracy & Hearing aids

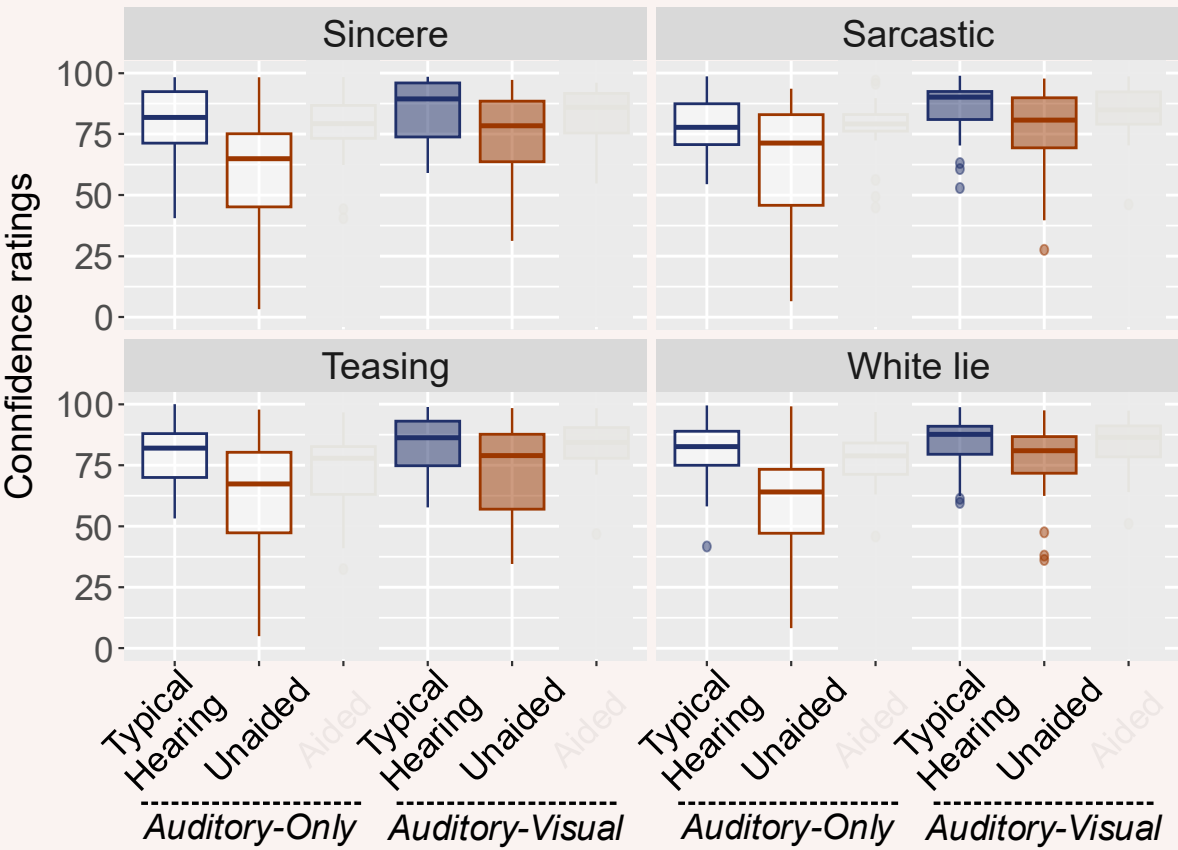


- Visual cues improved accuracy
- Greater accuracy when using hearing aids



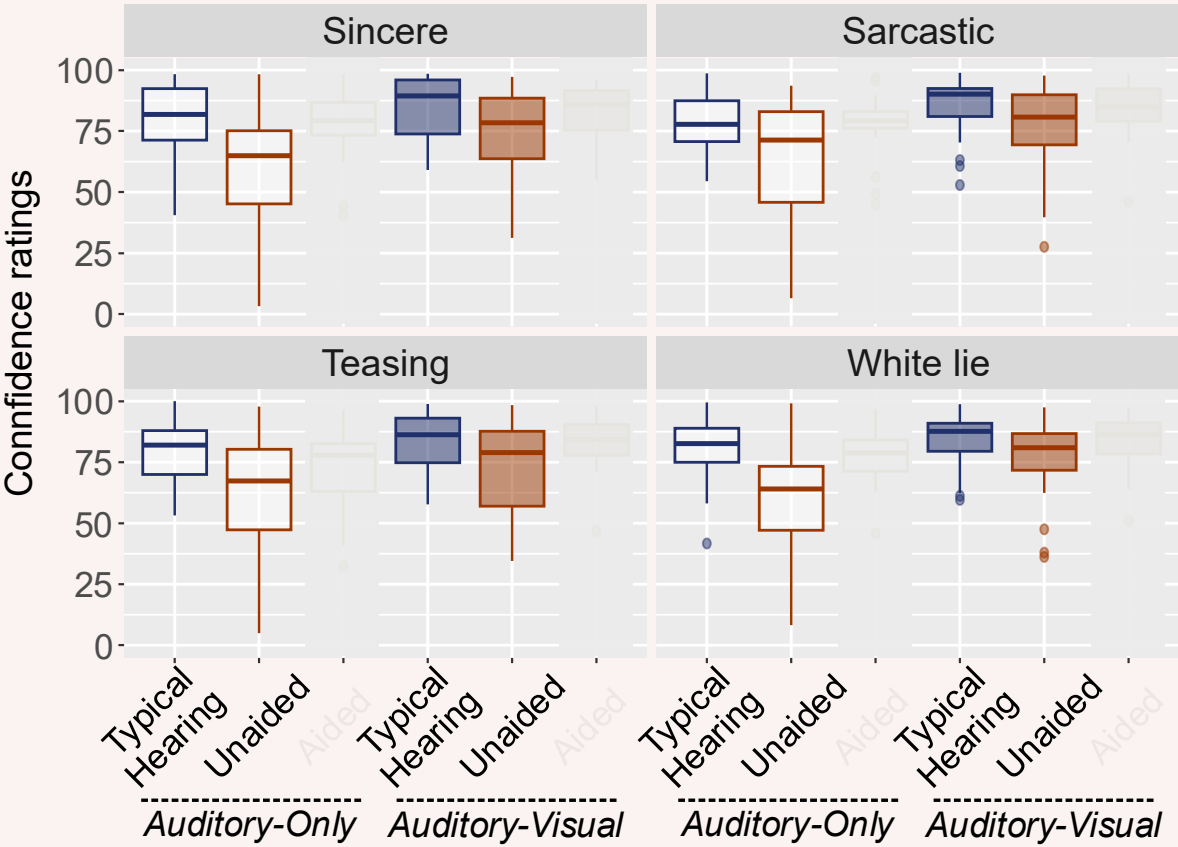
Intentions – Social subtext

Confidence & Hearing loss

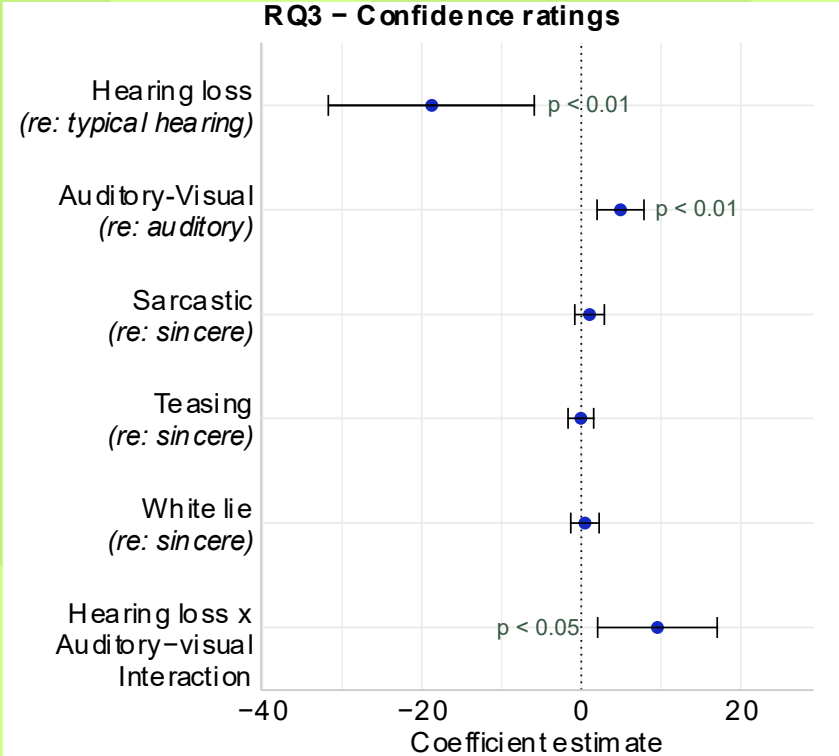


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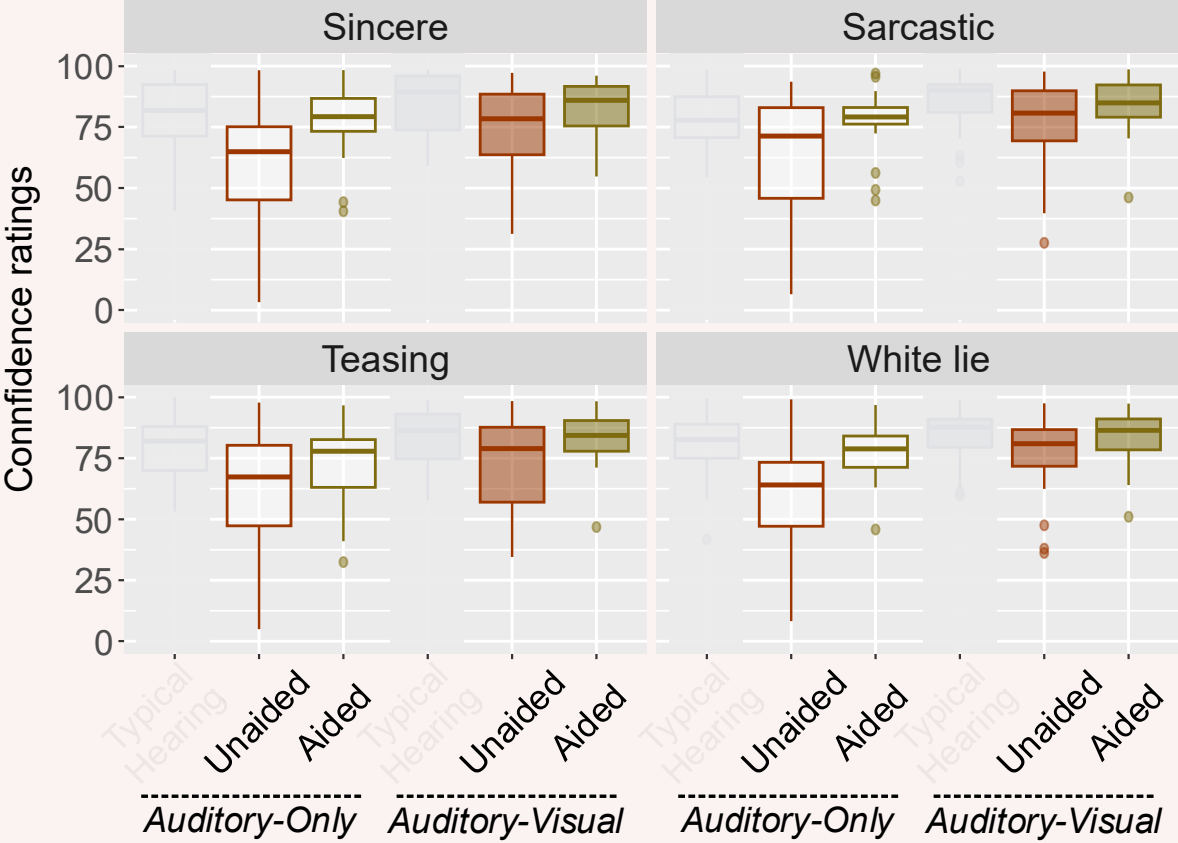


- Interactive effects of Modality and Hearing loss
- Lower confidence with hearing loss (*only significant in the auditory-only condition*)
- Greater benefit from visual cues in case of hearing loss



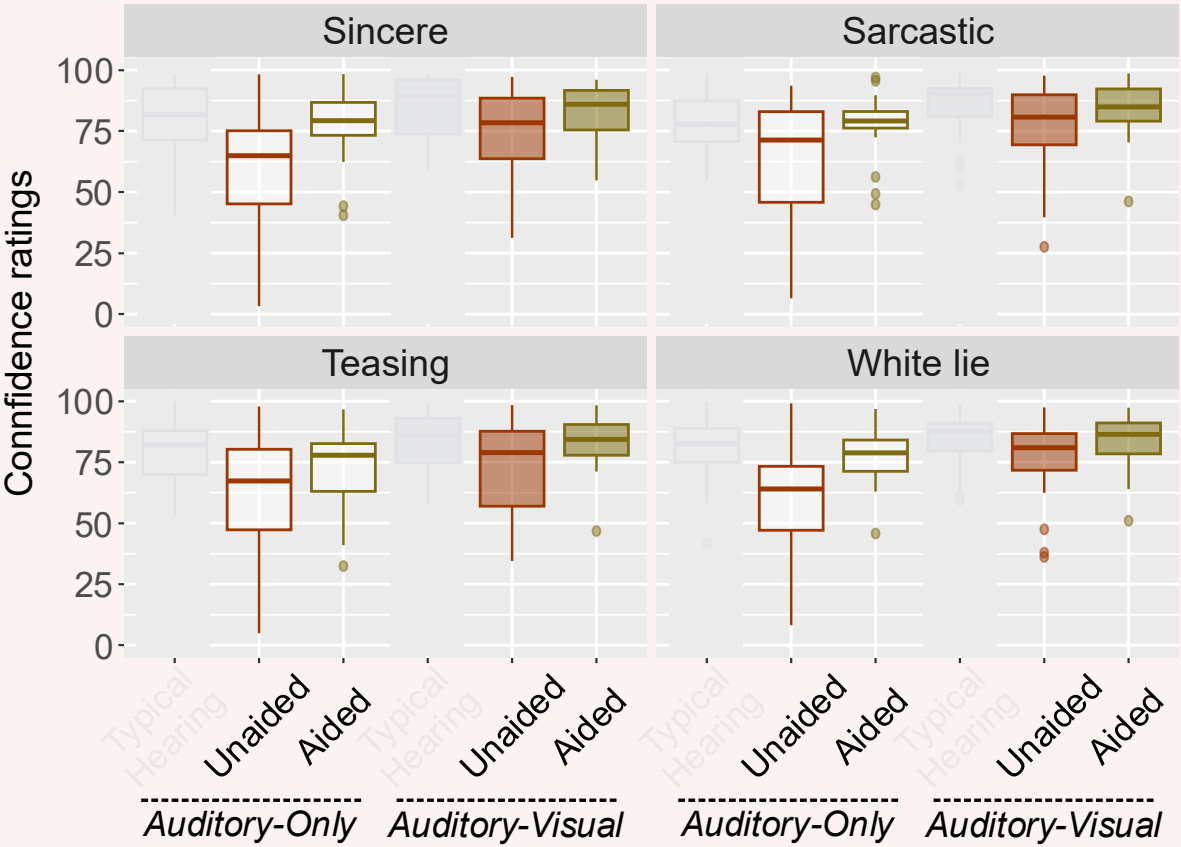
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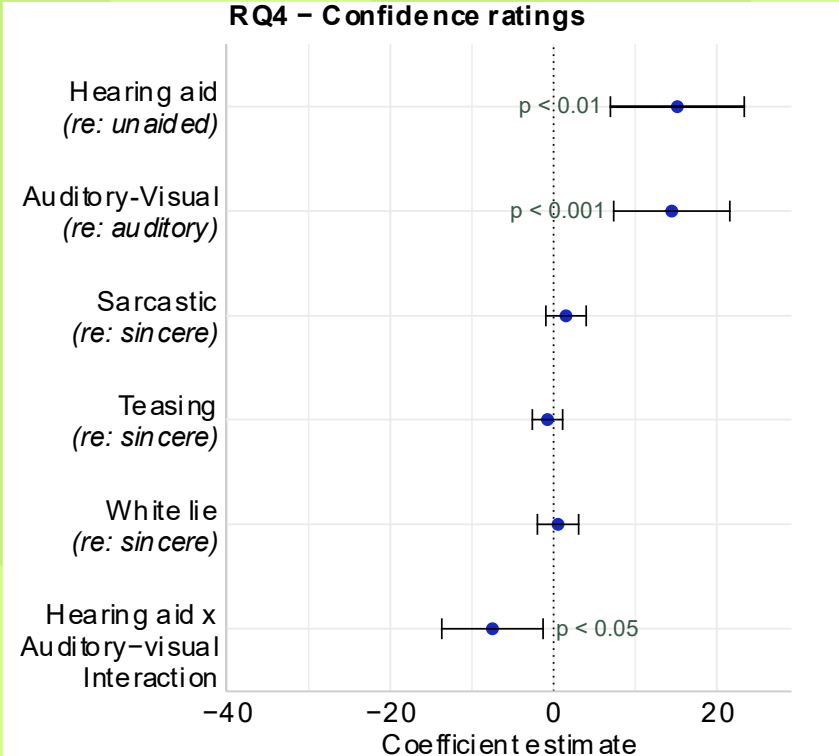


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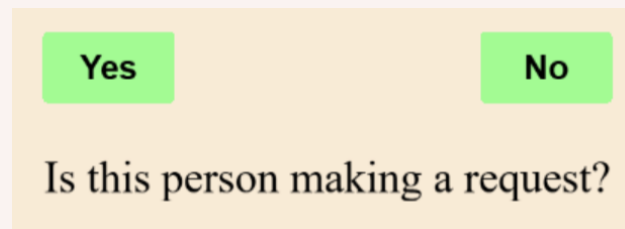


- Interactive effects of Modality and Hearing aids
- Higher confidence with hearing aids (*significant in both Modality conditions*)
- Hearing aids reduced the benefit from visual cues

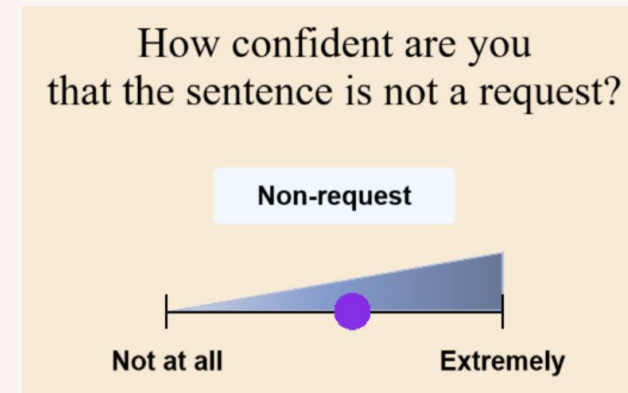


Intentions – Pragmatic intent

- **Corpus extract:** subset selected from the “Pros_scaled” corpus (Trott et al., 2023, Lang. Speech, 66(1))
- Audio-only recordings of single sentences, inherently ambiguous (e.g., *can you lift that box?*)
- Subset selected for this study: 4 yes/no questions and 14 speakers (*selection of stimuli associated with best performance in Trott et al. (2023), in which overall accuracy was close to chance*)
- N trials = 48 / participant



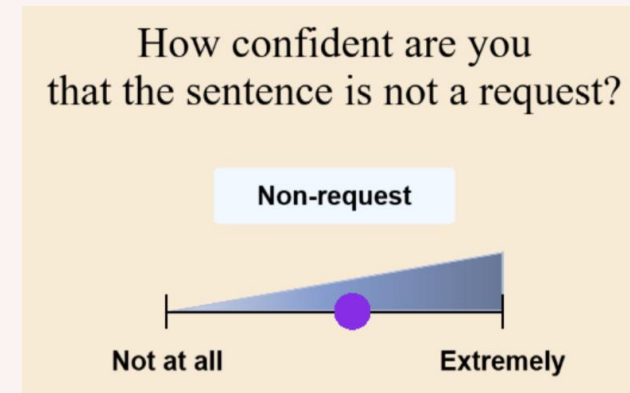
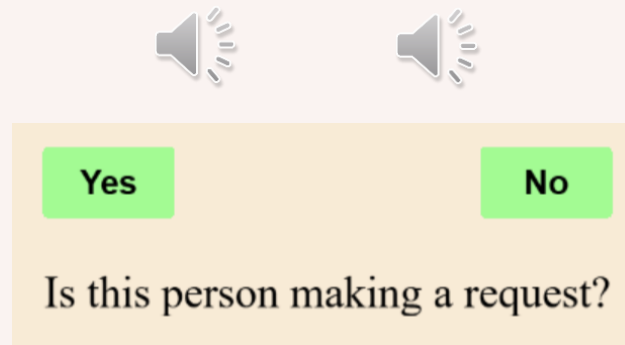
A screenshot of a user interface for a yes/no question. At the top, there are two green buttons labeled "Yes" and "No". Below the buttons, the question "Is this person making a request?" is displayed in a black serif font.



A screenshot of a user interface for a confidence scale. At the top, the question "How confident are you that the sentence is not a request?" is displayed in a black serif font. Below the question is a light blue box labeled "Non-request". Underneath this box is a horizontal line with a purple dot in the middle. The line is labeled "Not at all" on the left and "Extremely" on the right. A blue shaded area under the line tapers from left to right, representing a probability distribution.

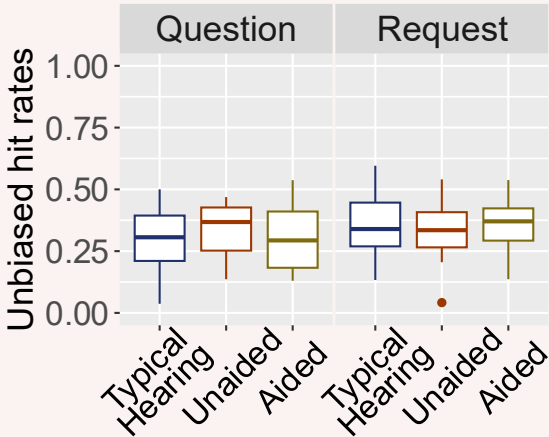
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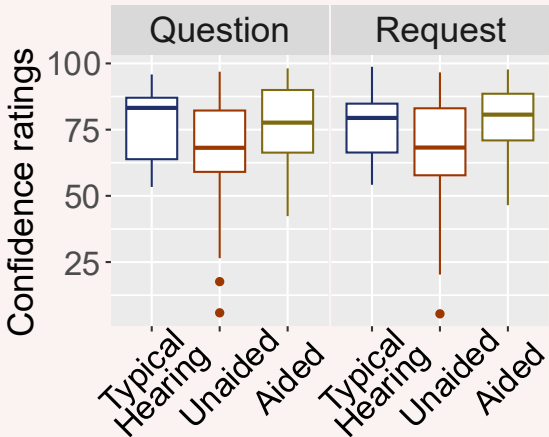


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Accuracy



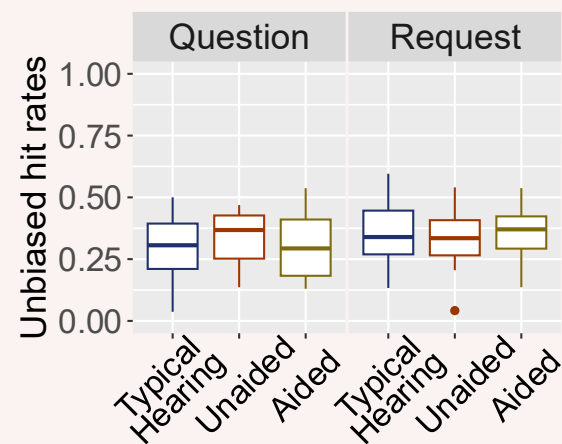
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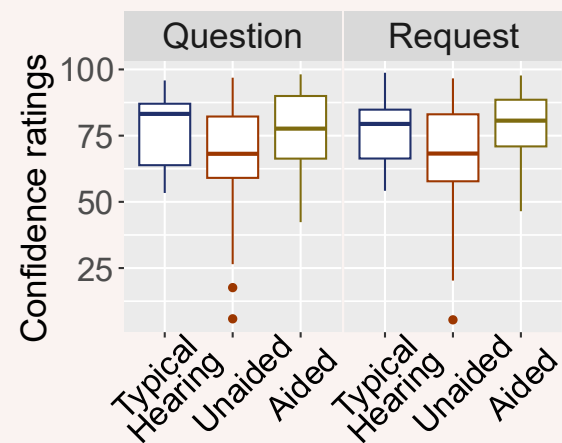
Intentions – Pragmatic intent

→ No effects on accuracy

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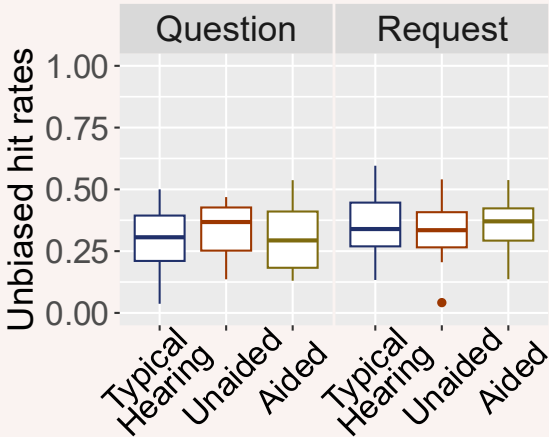


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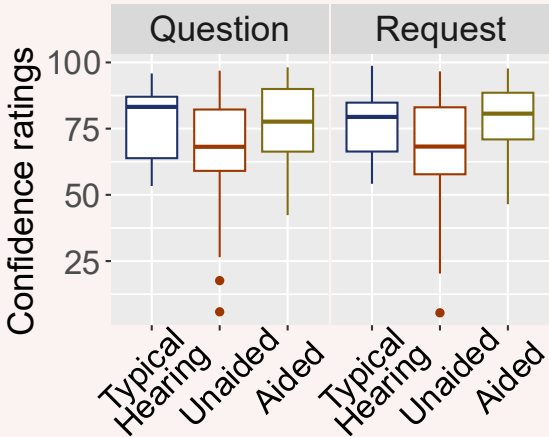


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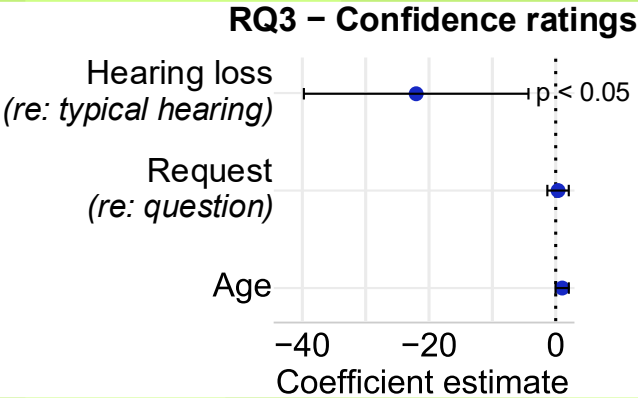


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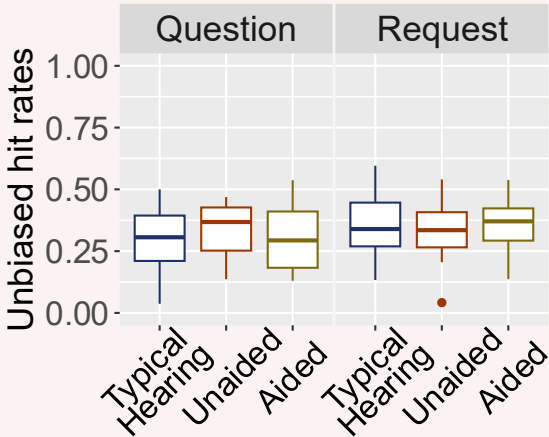
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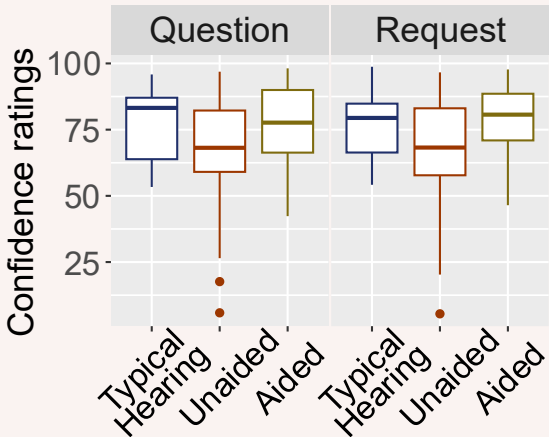


Intentions – Pragmatic intent

Accuracy

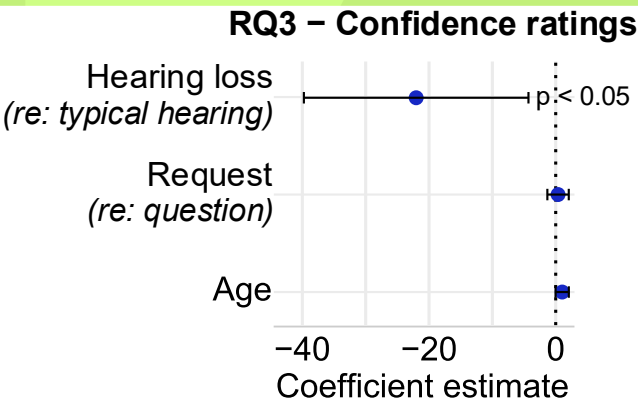


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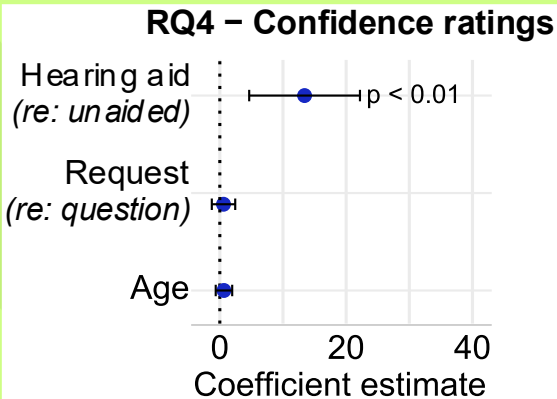


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→ Higher confidence with hearing aids



Conclusions & Discussion

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- A positive effect of hearing aids on confidence but not on performance was also observed in two affective prosody experiments focusing respectively on the recognition of 6 basic emotions and of 12 nuanced emotions (*for the latter, see upcoming Davis et al., 2026, J. Am. Acad. Audiol.*)

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- Confidence may be a critical clinical outcome, as it is likely to influence real-world social participation and communication behavior

THANK YOU FOR LISTENING!