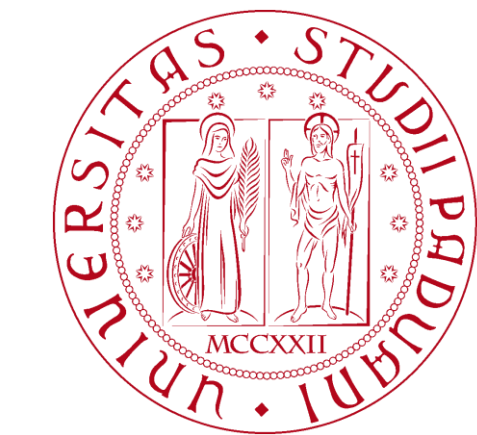# The role of degraded auditory input on predictive audiovisual language processing: the case of cochlear implant users

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INTRODUCTION

Language comprehension is
PROACTIVE: top-down prediction of information **facilitates bottom-up processing** [1,2] especially in challenging situations [3]
MULTIMODAL: seeing the mouth of the speaker influences speech perception [4]
Comprehending speech is more than simply perceiving sounds. What happens when the sensory input for speech is chronically sub-optimal?
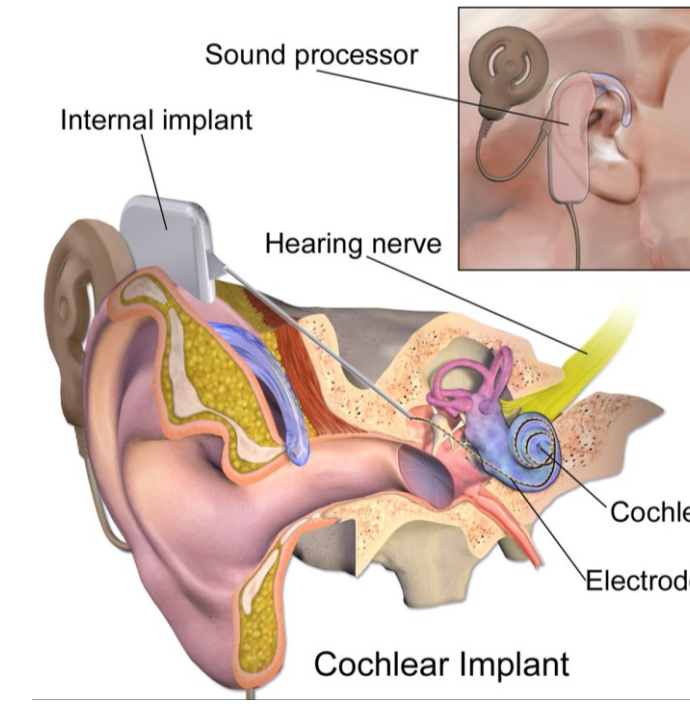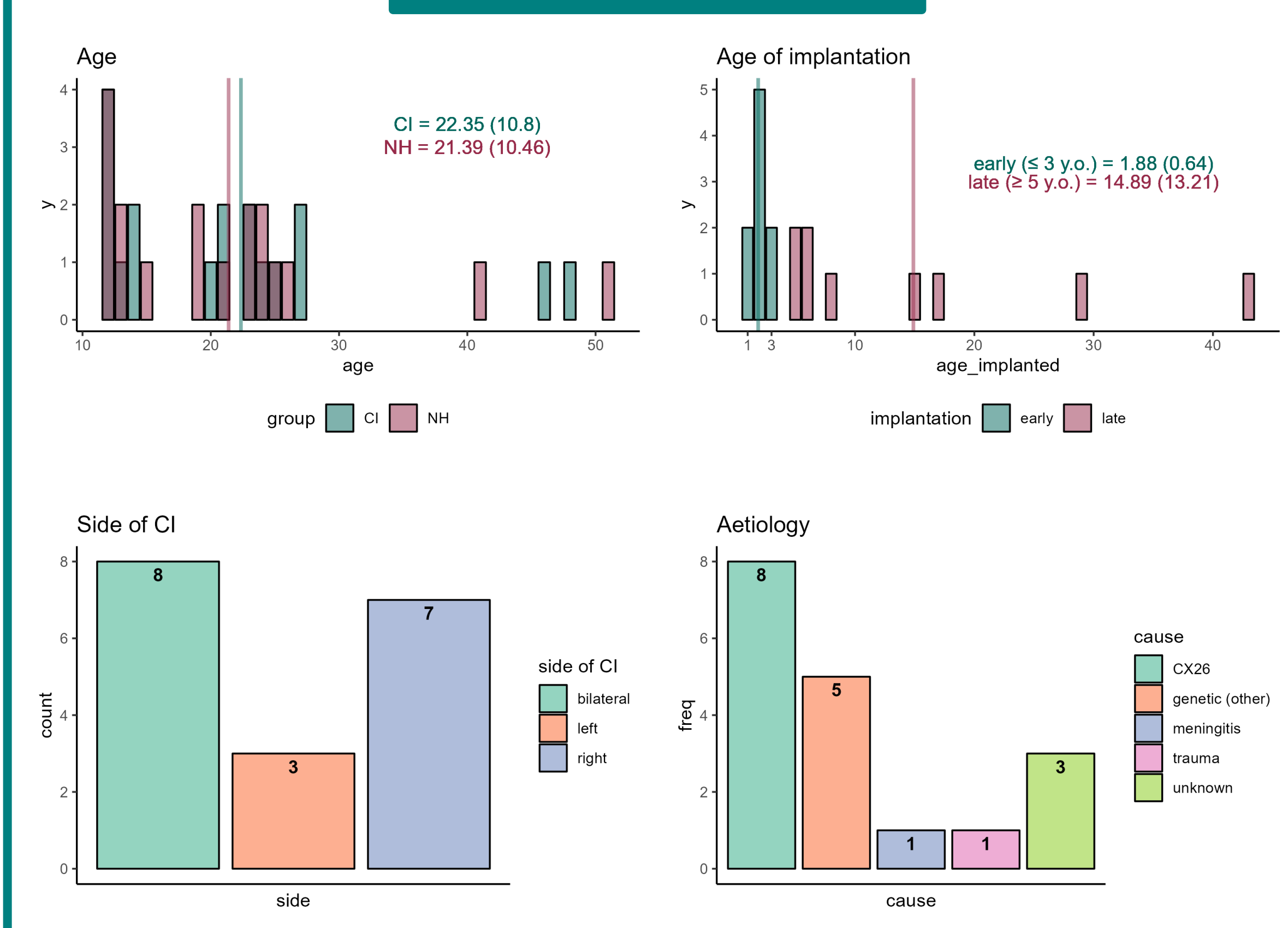

Cochlear implants (CI) are neuroprostheses that allow **deaf people** to perceive sounds. However, the **encoding of speech sounds is suboptimal** [5,6]. Therefore, for CI users, **visual mouth cues and predictability** may be particularly relevant to comprehend speech.
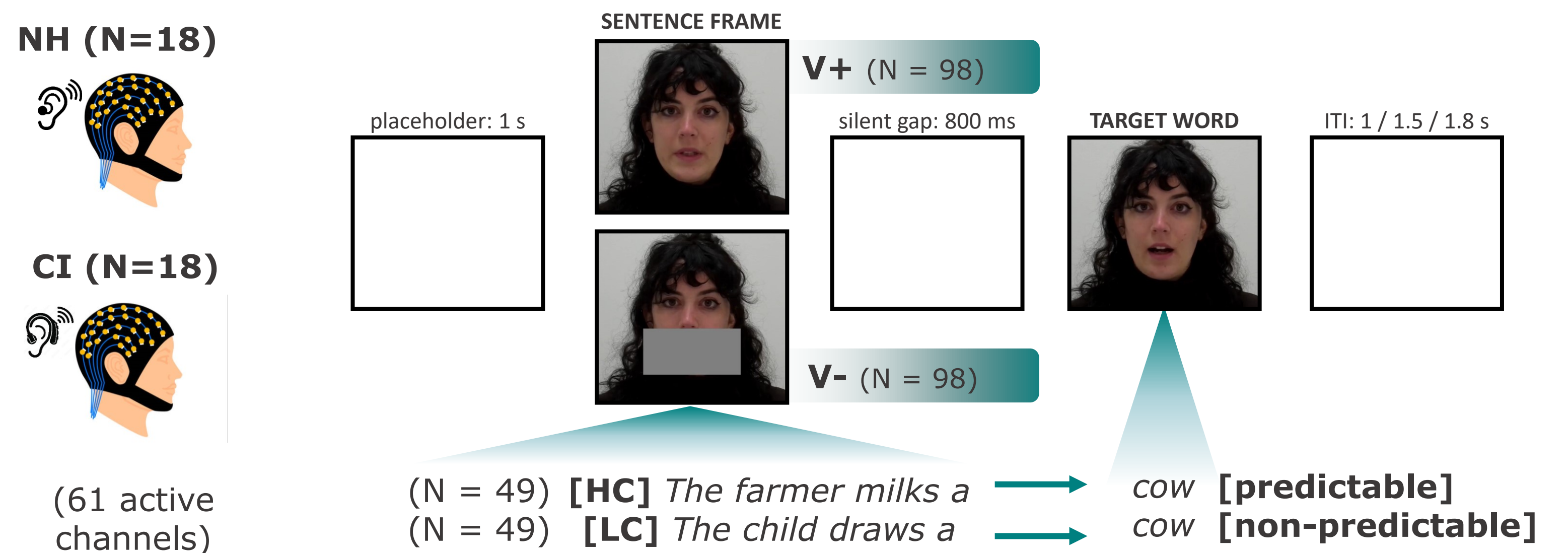
Does **visual information about the speaker's mouth** interact with **predictability**?
Are these sources of information **differently exploited by CI users** to compensate for a suboptimal speech input?
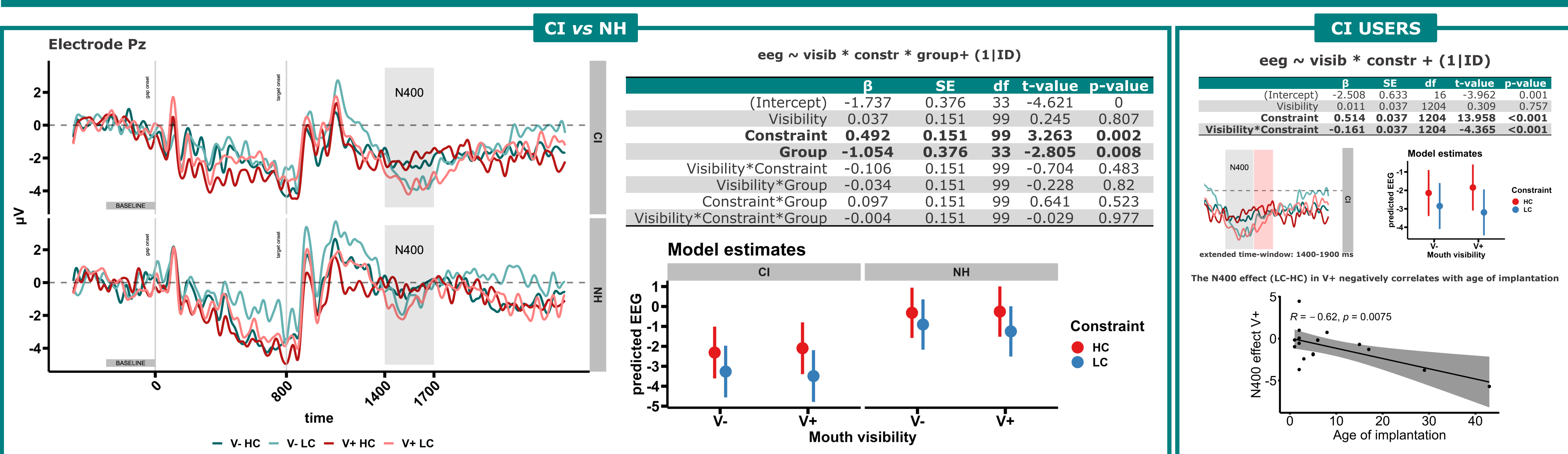
METHODS

PARTICIPANTS

EEG SESSION: AUDIOVISUAL SPEECH COMPREHENSION TASK

NH (N=18)

CI (N=18)

(61 active channels)

SENTENCE FRAME

V+ (N = 98)

V- (N = 98)

placeholder: 1 s | silent gap: 800 ms | TARGET WORD | ITI: 1 / 1.5 / 1.8 s

(N = 49) **[HC]** *The farmer milks a* → *cow* **[predictable]**
(N = 49) **[LC]** *The child draws a* → *cow* **[non-predictable]**

LANGUAGE EVALUATION TASKS

PRODUCTION
- Semantic and phonological fluency
- Sentence generation

COMPREHENSION
- Lexical decision
- Sentence-picture matching

EXPLORATORY ERP RESULTS

CI *vs* NH

eeg ~ visib * constr * group+ (1|ID)

	β	SE	df	t-value	p-value
(Intercept)	-1.737	0.376	33	-4.621	0
Visibility	0.037	0.151	99	0.245	0.807
Constraint	**0.492**	**0.151**	**99**	**3.263**	**0.002**
Group	**-1.054**	**0.376**	**33**	**-2.805**	**0.008**
Visibility*Constraint	-0.106	0.151	99	-0.704	0.483
Visibility*Group	-0.034	0.151	99	-0.228	0.82
Constraint*Group	0.097	0.151	99	0.641	0.523
Visibility*Constraint*Group	-0.004	0.151	99	-0.029	0.977

Model estimates

CI USERS

eeg ~ visib * constr + (1|ID)

	β	SE	df	t-value	p-value
(Intercept)	-2.508	0.633	16	-3.962	0.001
Visibility	0.011	0.037	1204	0.309	0.757
Constraint	0.514	0.037	1204	13.958	<0.001
Visibility*Constraint	-0.161	0.037	1204	-4.365	<0.001

extended time-window: 1400-1900 ms

The N400 effect (LC-HC) in V+ negatively correlates with age of implantation

$R = -0.62, p = 0.0075$

PRELIMINARY OBSERVATIONS

1. Main effect of constraint (LC < HC)
2. No main effect or interaction of mouth visibility (in the whole sample)
3. Main effect of group (CI < NH)
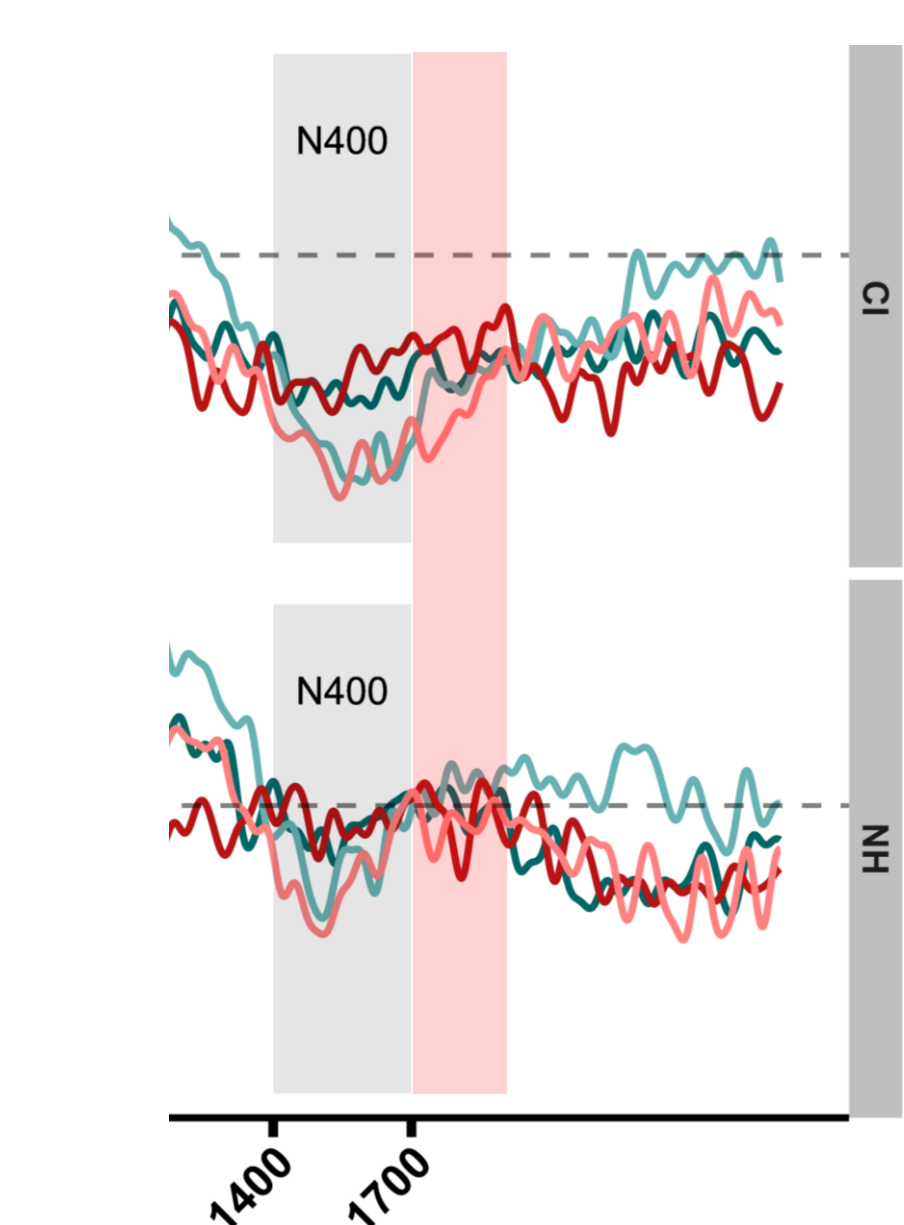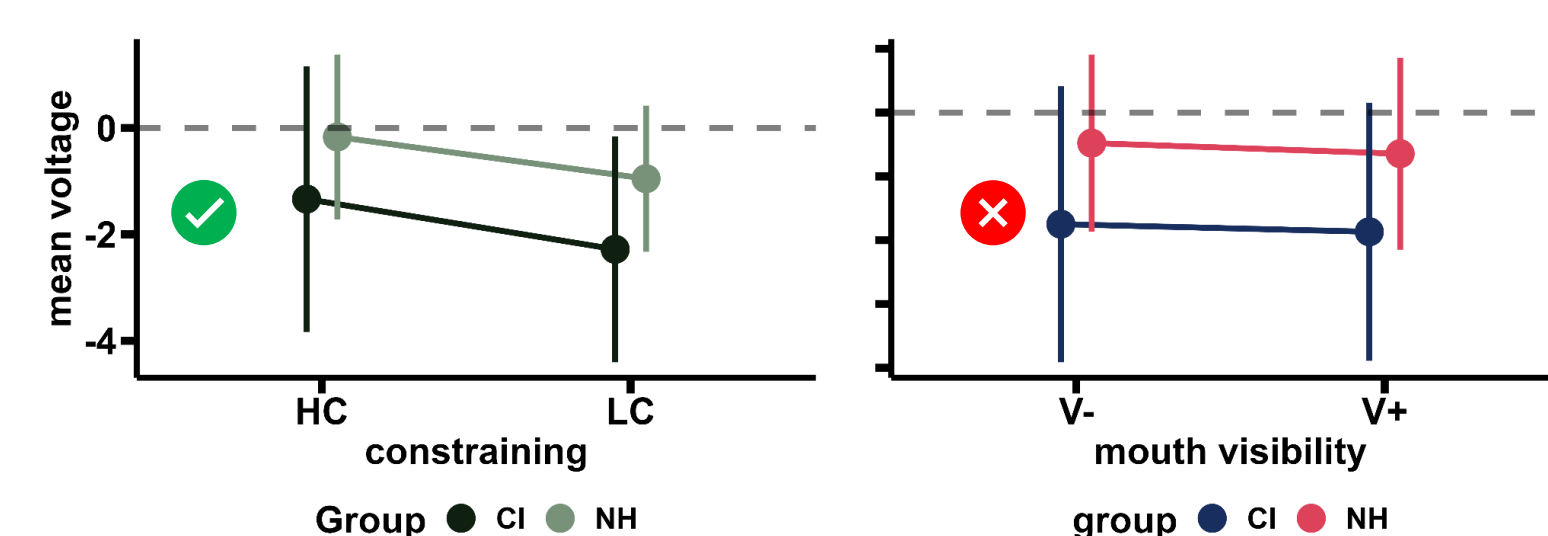
4. Longer latency in CI? Other measures to capture group differences?
5. When looking at a longer time-window in CI only, interaction mouth visibility × constraint
6. The N400 effect in V+ correlates with age of implantation (later implantation = greater effect when the mouth was visible during the sentence)

$R = -0.62, p = 0.0075$
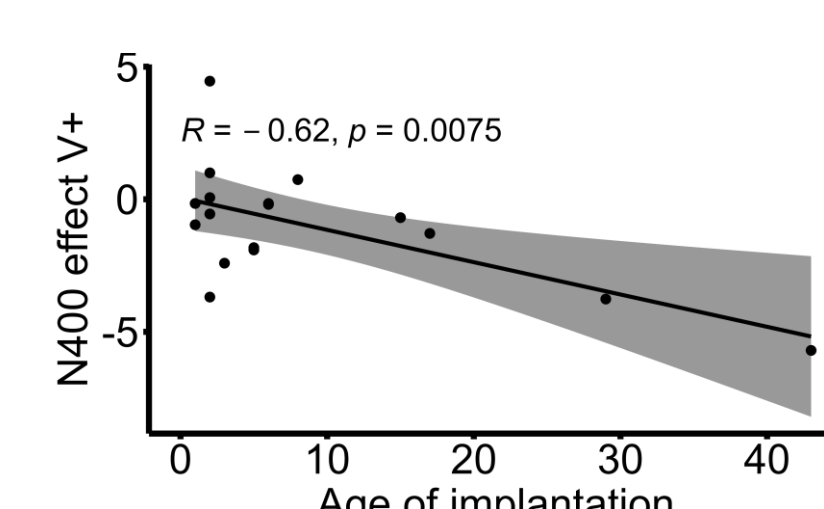
NEXT STEPS

- Pre-target alpha-beta oscillatory activity
- Source estimation (caveat: loss of channels in CI users)
- PCA on language tasks data to identify a way to discriminate participants' language skills, include as a predictor in the model
- Anticipatory negative slow wave: fit a line in the pre-target interval and analyze the slope
- Correlations between brain data and language skills

Alpha 8-12 Hz
Beta 13-30 Hz
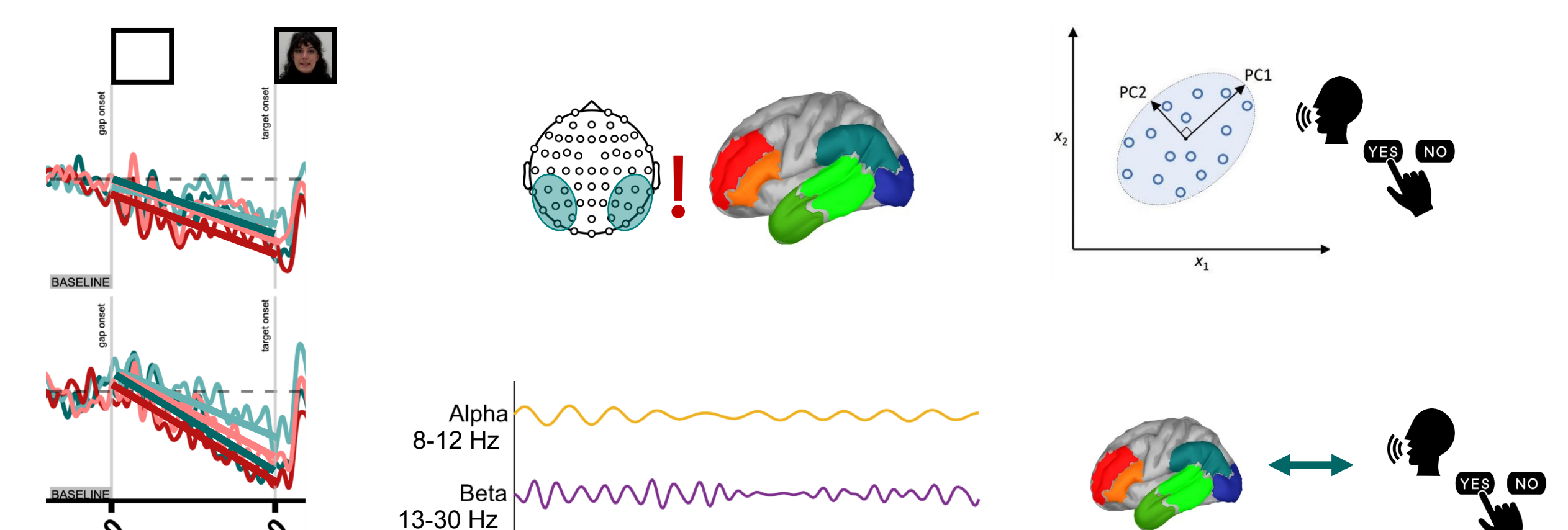
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