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► To cite this version:

Robin Gigandet, Melisa Yavuz, Bing Li, Tatjana Nazir. Unraveling the interplay between verbal utterances, bodily shape, and beliefs: novel insights into embodied language processing. Annual Embodied and Situated Language Processing (ESLP), Sep 2023, Messina, Italy. hal-04428779

HAL Id: hal-04428779

<https://hal.univ-lille.fr/hal-04428779v1>

Submitted on 4 Apr 2024

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UNRAVELING THE INTERPLAY BETWEEN VERBAL UTTERANCES, BODILY SHAPE, AND BELIEFS: NOVEL INSIGHTS INTO EMBODIED LANGUAGE PROCESSING



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SCALab

SCS SCIENCES & CULTURES DU VISUEL

ABSTRACT

Embodied cognition theories propose that perception is influenced by our bodily experiences. Here we explored the significance of coherence between verbal utterances and the physical appearance of a speaker - a limbless robot. Our goal was to understand how the lack of limbs on a robot affects our perception when it discusses limb-related actions. We hypothesized that our own bodily experiences allow us to recognize inconsistencies in such situations. To measure this, we utilized the N400 effect, an electrophysiological marker of semantic processing. Additionally, we investigated participants' beliefs about the robot possibly having concealed limbs, a concept popularized in media (e.g., Eve from Pixar's Wall-E). Surprisingly, about 70% of participants believed the robot could have hidden limbs, indicating a prevailing inclination toward beliefs contradicting the robot's physical evidence. Critically, only the 30% of "non-believers" demonstrated the anticipated N400 effect; those who believed in potential hidden limbs had a diminished or non-existent N400 response. These results shed light on the complex relationship between embodied experiences and beliefs and how they jointly influence language comprehension processes.

METHODS

Buddy
(Blue Frog Robotics)

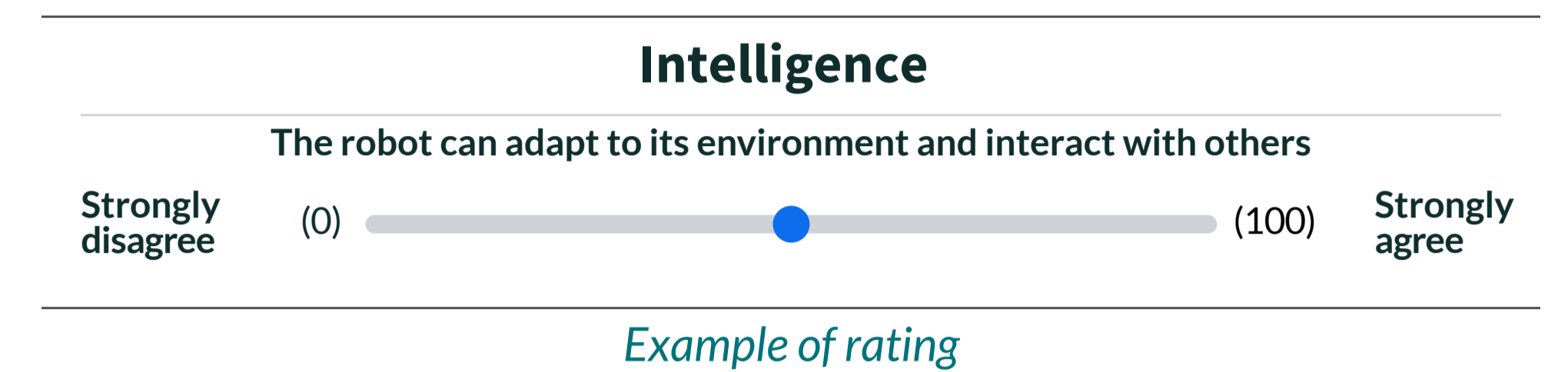
CONGRUENT
e.g. to talk

INCONGRUENT
e.g. to applaud

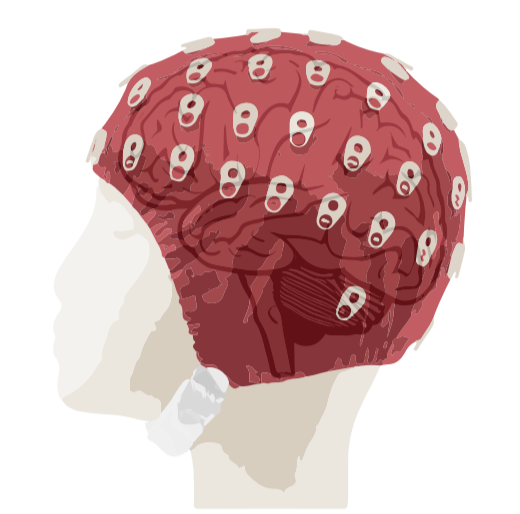
60 videos
comprising 30 where Buddy made contradictory statements regarding its physical abilities
"To go upstairs, I will take the lift/stairs"

Questionnaire

- 5 items** about the robot's cognitive abilities
Imagination, Intelligence, Independence, Creativity, Talkativity
- 2 items** about the possibility that the robot could have hidden arms or legs
**Because popular culture often portrays robots with surprising hidden capabilities*



Dependent measures
N400 component
Questionnaire assessing perceptions about the robot

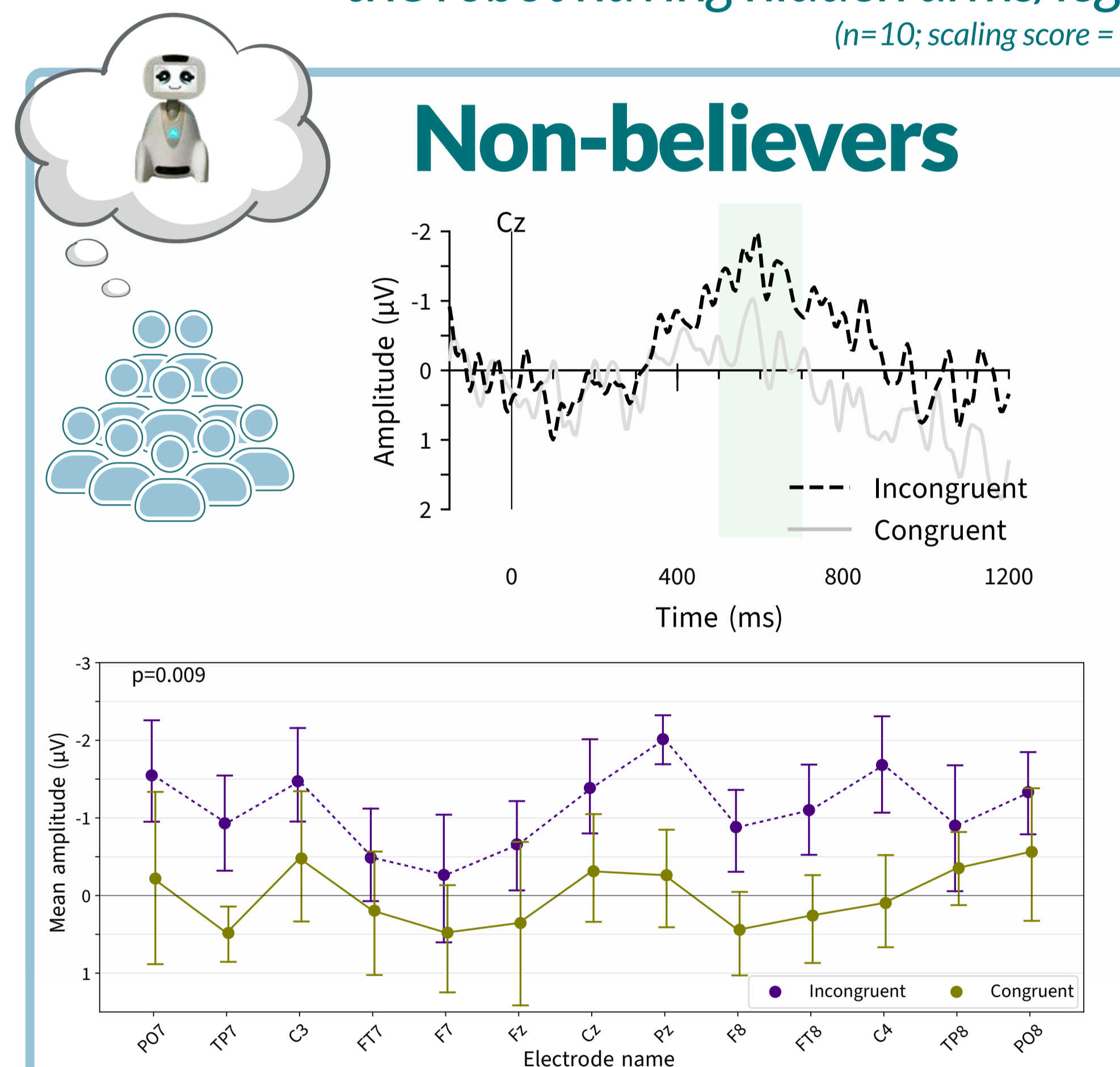


RESULTS

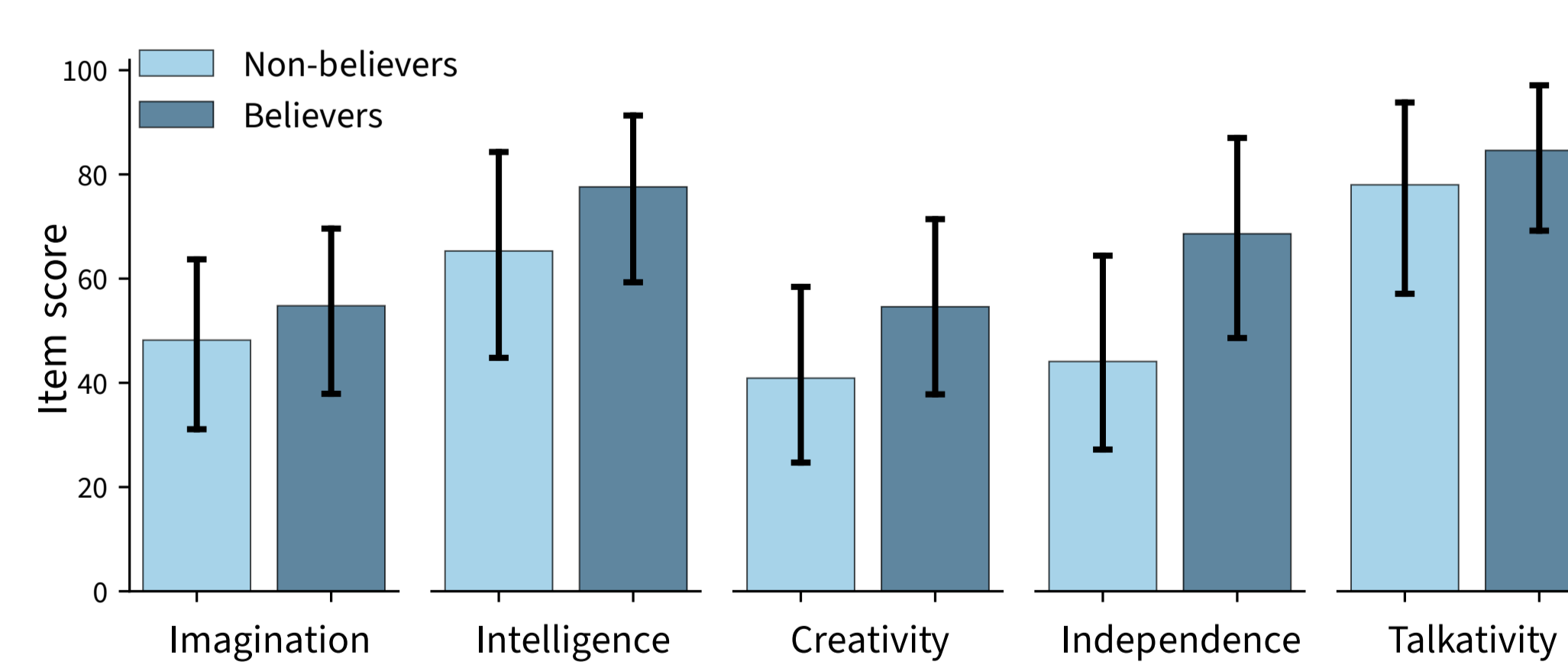
BELIEFS ABOUT HIDDEN LIMBS

Of 27 participants we separated the participants into 2 groups:

those who didn't consider the possibility of the robot having hidden arms/legs
(n=10; scaling score = 0)

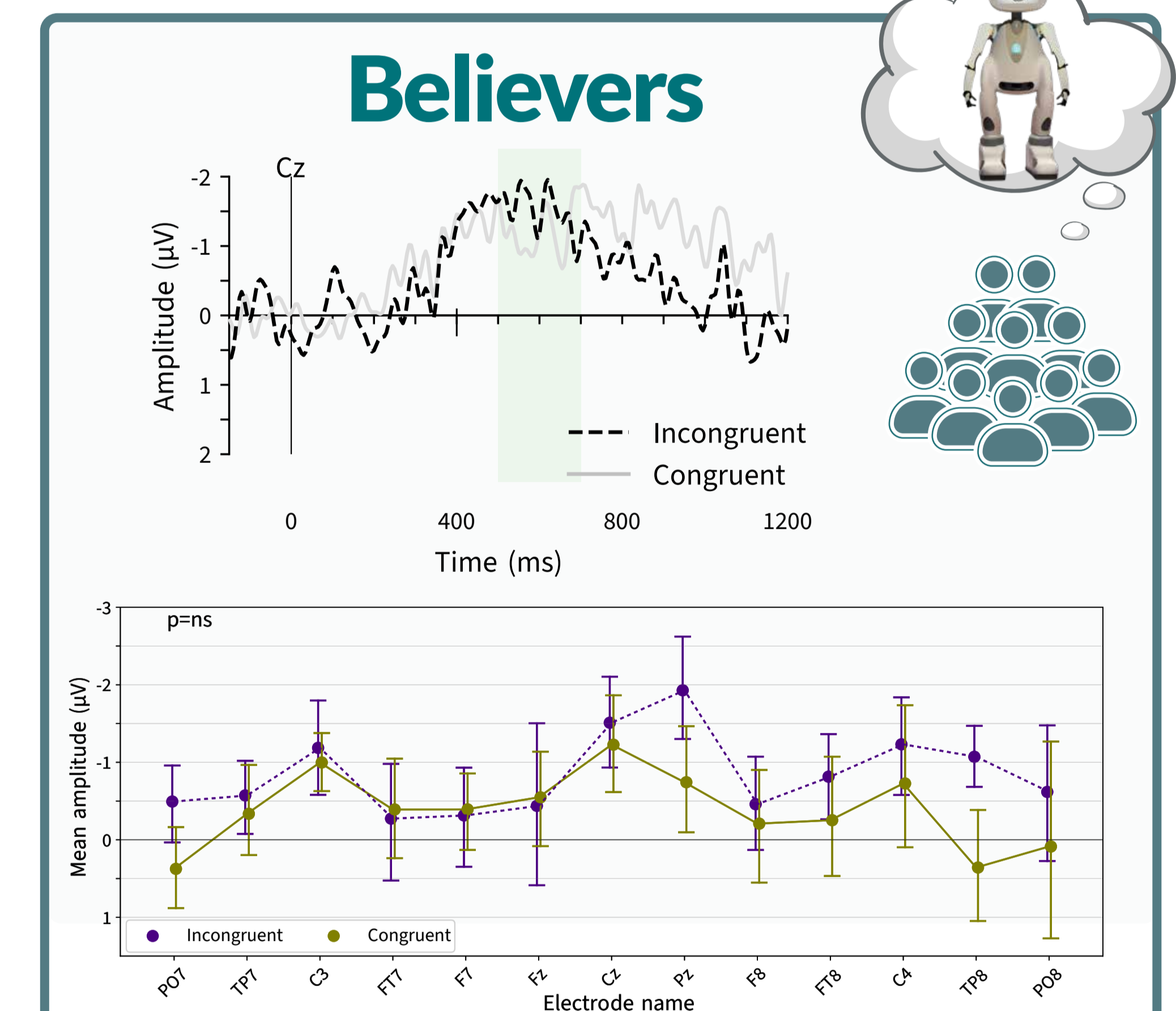


↳ an increased N400 amplitude was found when the sentences were **incongruent** with the robot's physical appearance

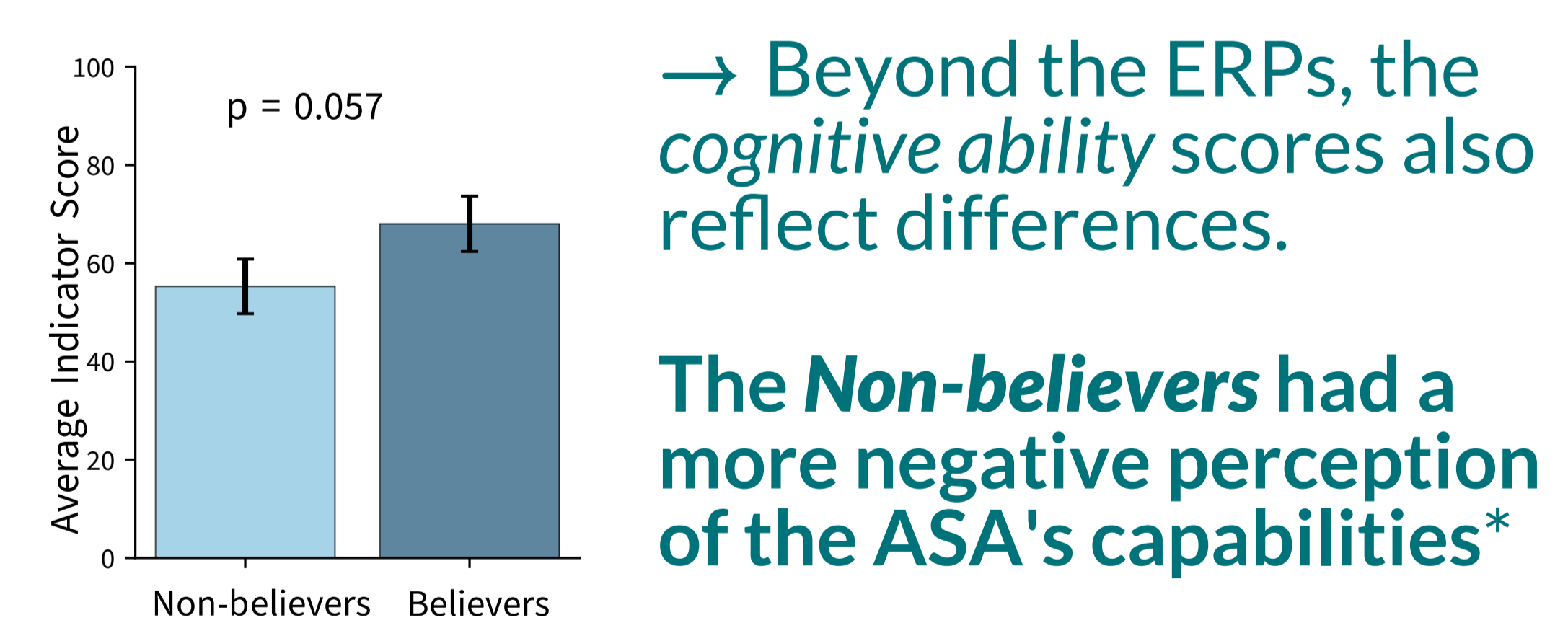


For the 27 participants: Imagination (54.51), Intelligence (73.48), Independence (53.18), Creativity (52.40), Talkativity (79.77)
For the "non-believers": Imagination (48.2), Intelligence (65.3), Independence (44.1), Creativity (40.9), Talkativity (78.0)
For the "Believers": Imagination (54.8), Intelligence (77.6), Independence (68.6), Creativity (54.6), Talkativity (84.6)

those who did consider the possibility of the robot having hidden arms/legs
(n=10; scaling score = [38-86])



↳ the distinction between **incongruent** & **congruent** sentences nearly disappears



→ Beyond the ERPs, the cognitive ability scores also reflect differences.

The Non-believers had a more negative perception of the ASA's capabilities*

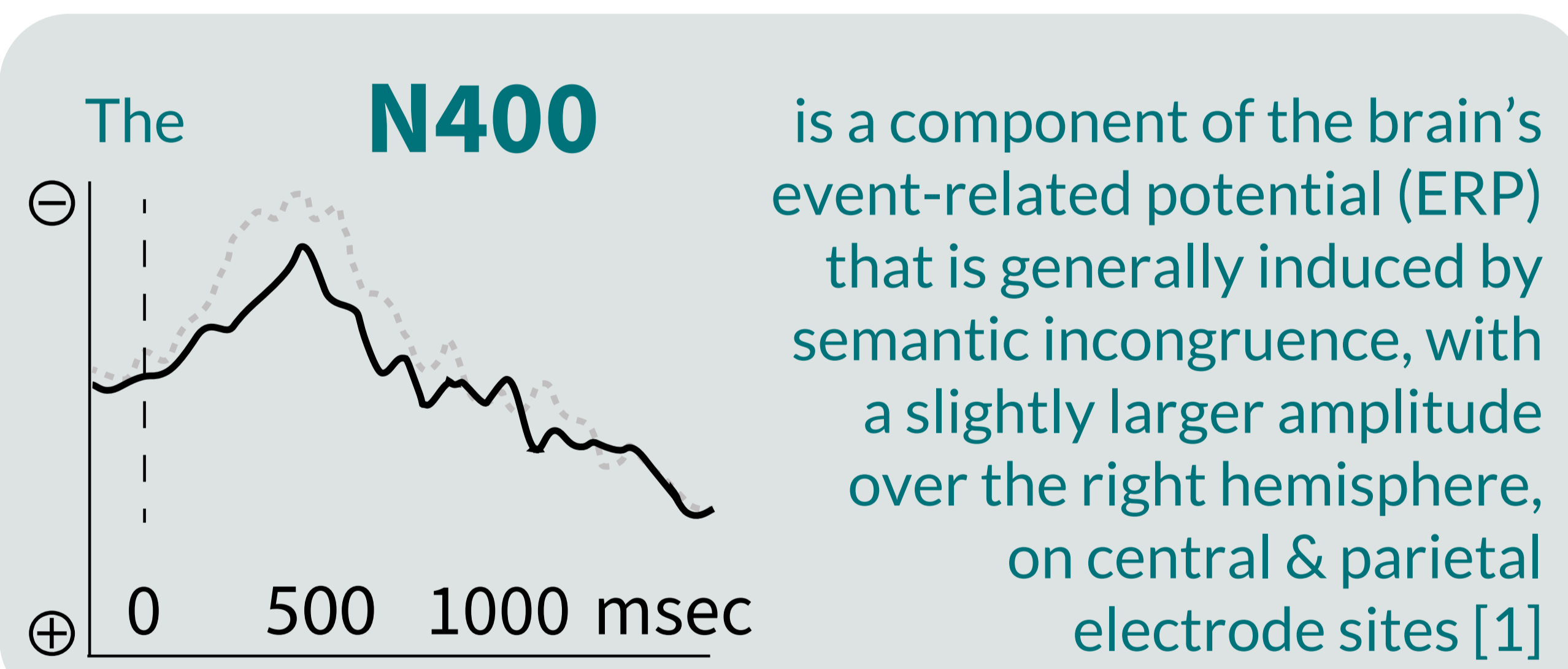
*Note that the effect is marginally significant, probably due to the small sample size.

CONCLUSION

Our findings highlight the remarkable human ability to reconcile the discrepancy between the appearance of the robot and the conveyed meaning. The participants' beliefs significantly influenced both their neural and language processing. These results provide valuable insights into the intricate interplay between embodied experience and beliefs, and sheds light on the complex mechanisms underlying the interpretation of information. Preexisting beliefs influenced how we process and understand messages, showcasing the influence of cognitive frameworks during language processing.

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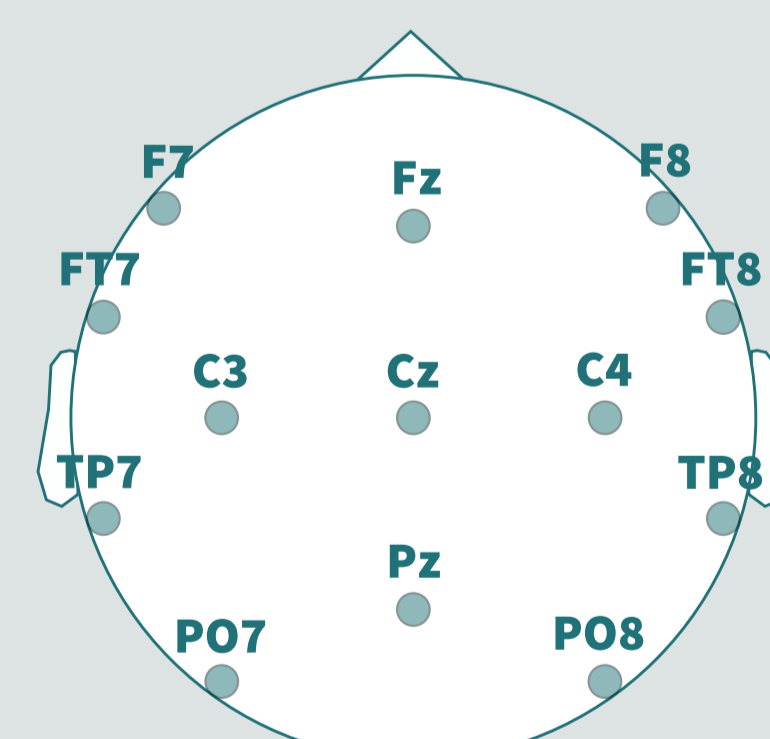
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DATA PROCESSING

EEGLab [2] & MNE Python [3]

- window of interest [500-700ms]
- filter [0.5Hz - 30Hz]
- sampling rate [200Hz]
- epochs [-150ms - 1200ms]
- baseline [-150ms - 0ms]
- 13 electrodes of interest



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ORIGINAL PAPER

Gigandet et al. (2023). The "Eve effect bias": Epistemic Vigilance and Human Belief in Concealed Capacities of Social Robots. *2023 IEEE International Conference on Advanced Robotics and Its Social Impacts (ARSO)*, 15-20. <https://doi.org/10.1109/ARSO56563.2023.10187469>

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