INNER SPEECH PROPENSITY PREDICTS PHASE-LOCKED AND NON-PHASE-LOCKED EEG ACTIVITY DURING CUED OBJECT RECOGNITION

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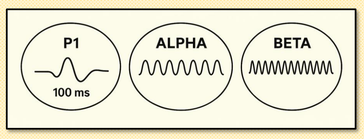
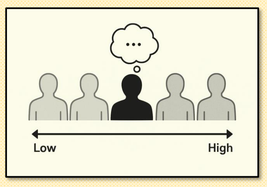
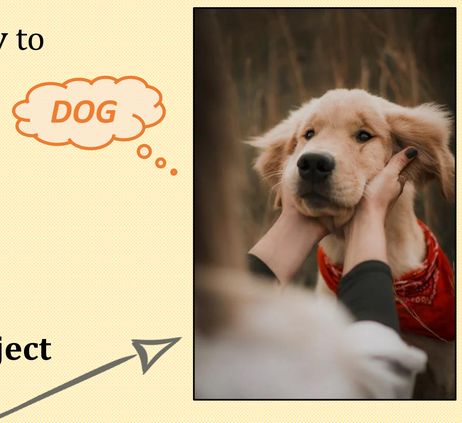
INTRODUCTION

Alpha/beta oscillations and **P1** responses reflect **language effects** on object **recognition**[3]



People **differ** in their **propensity** to experience **inner speech**[4]





These differences impact **object recognition**[3]

Electrophysiological correlates** are **elusive

Language augments visual perception via categorical warping[1,2]

What is the EEG signature of the effects of individual differences in inner speech propensity on visual recognition?

METHOD

Participants

- Healthy **German-speaking** adults (**n = 61**; 16 ♂, mean age = 23.9)

Measures

- **Internal Verbalization** scale of the Internal Representations Questionnaire – German[1]
- **Name agreement** (human ratings, n = 30)
- Image **typicality** (human ratings, n = 27)
- **Semantic** and **phonological** similarity (human ratings, n = 49)

EEG Data and Statistics

- Pre-target pseudonormalized **posterior alpha** and **beta** power
- **P1** (75-124 ms; posterior) and **N400** (430-650ms; frontocentral) amplitude to targets
- **Single-trial power**:
  - One **linear mixed model** per frequency/time window of interest (0-1.3 s from word cue onset, **every 200 ms**; 100 ms overlap)
    - **False-discovery rate correction** for multiple comparisons
- **Single-trial P1** and **N400** amplitude:
  - Separate **linear mixed models** per component

DISCUSSION

- **Individual differences** in **inner speech** propensity are reflected in pre-target posterior **alpha** and **beta** activity.
- **Alpha** and **beta** oscillations: **different functions** depending on **inner speech** propensity?
- **Visual processing** as indexed by the **P1** is **influenced** by individual differences in **inner speech** traits **and stimulus** features.
- **EEG** measures **predict response times** depending on **inner speech** and **item** characteristics.

Our brain rhythms reveal the silent voice in the head.

REFERENCES

[1]Lupyan, G. (2012). Linguistically modulated perception and cognition: The label-feedback hypothesis. *Frontiers in psychology*, *3*, 54.

[2]Lupyan, G., Rahman, R. A., Boroditsky, L., & Clark, A. (2020). Effects of language on visual perception. *Trends in cognitive sciences,* 24(11), 930-944.

[3]Morucci, P., Giannelli, F., Richter, C. G., & Molinaro, N. (2025). Spoken words affect visual object recognition via the modulation of alpha and beta oscillations. *Frontiers in Neuroscience*, *19*, 1467249.

[4]Borges, P. B., & Mueller, J. L. (2024). Interindividual Differences in Higher and Lower-Order Object-Related Cognition: The Role of Inner Speech. *Collabra: Psychology*, 10(1).

MATERIALS AND TASK

- Familiar **words** and **object** photographs
- Pseudorandomized matching (320) and **non-matching** (320) trials

Phonological & semantic similarity

\- ⟷ +

- ✓ **Name agreement** > 50%
- ✓ **Only non-matching** trials
- ✓ **Word-picture** condition

Word-picture verification task

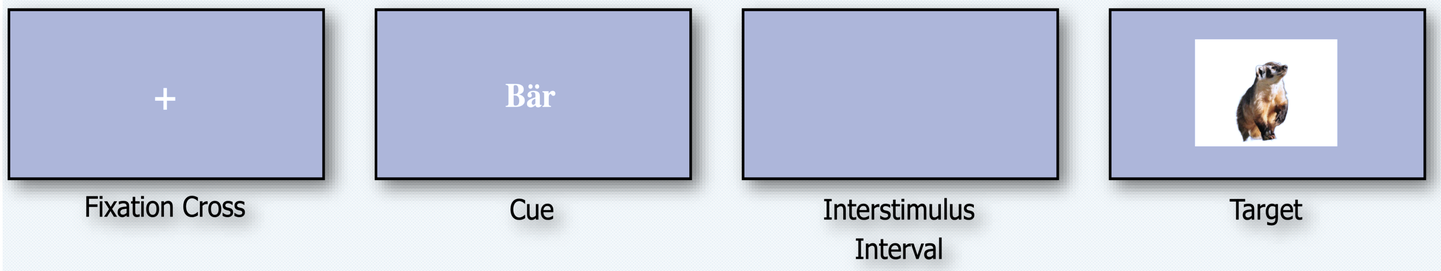


Fig. 1: Trial structure in the word picture verification task.
Non-matching trials included more unrelated and more (semantically or phonologically) related items. Example of an item with high semantic similarity.

RESULTS

Internal Verbalization Effects on Alpha and Beta Power

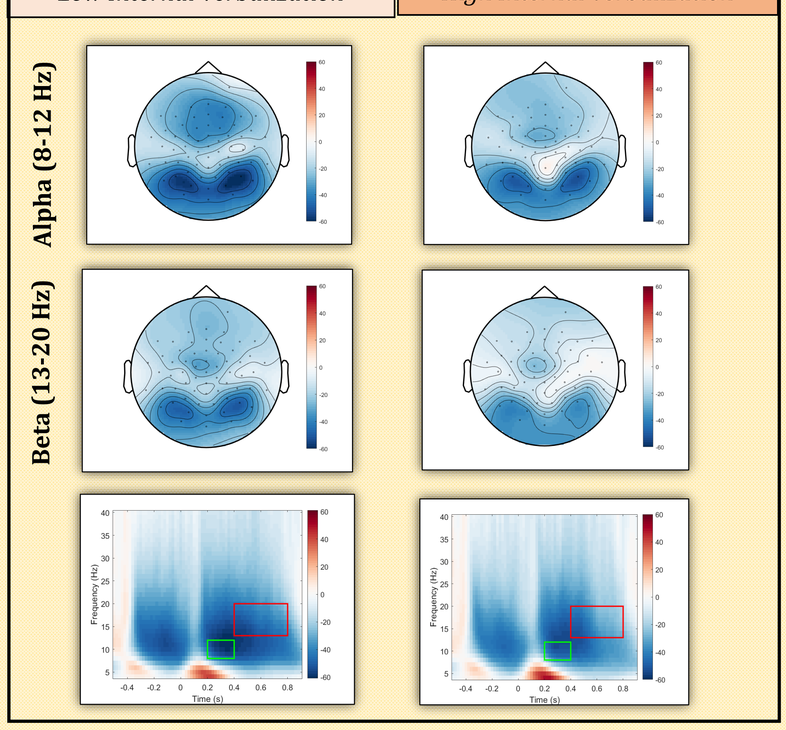


Fig. 2: Top: Topographical plots from 1st half of trials. Bottom: Time-frequency representations. Time window for alpha (left-lateralized) = 200-400 ms (green rectangle). Time window for beta (bilateral)= 400-800 ms (red rectangle).

Beta Power Effect on RT

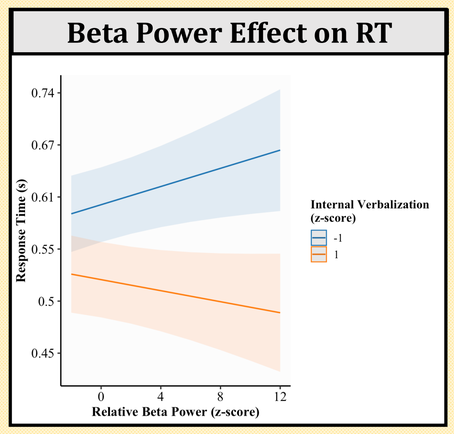


Fig. 3. Beta power – Internal Verbalization interaction on RT.

ERPs per Typicality Group at P10

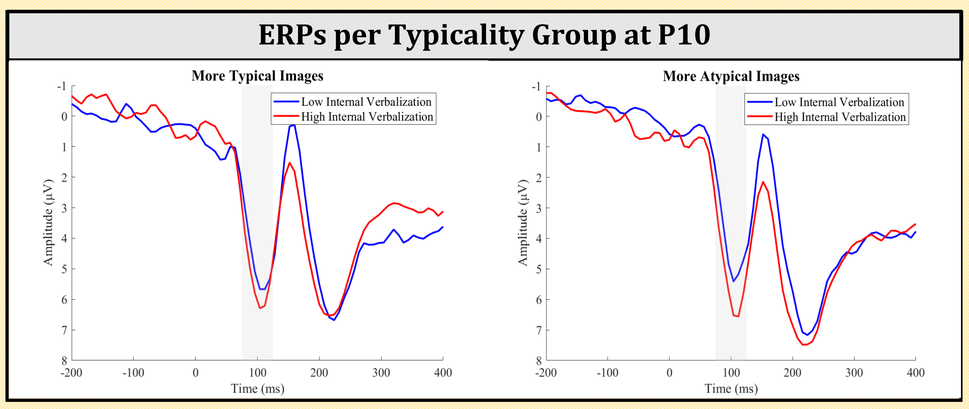


Fig. 4. ERPs per typicality group (median split) at channel P10.

P1 Interaction Effects on RT

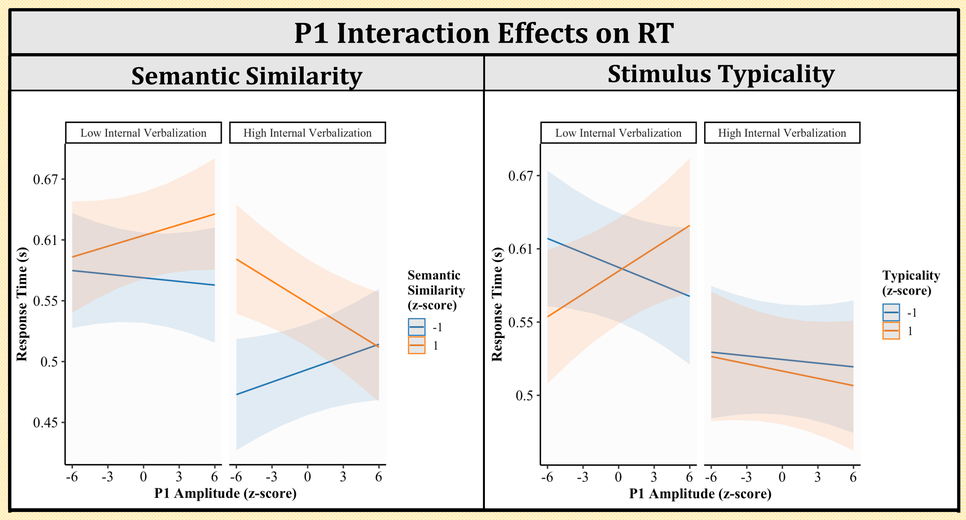


Fig. 5. Left: Interaction between P1 amplitude and semantic similarity on RT. Right: Interaction between P1 amplitude and object typicality ratings on RT.