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Engineering Creativity: Electrophysiological responses to Novel Metaphors differ as a function of Prior Knowledge

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Background

Novel metaphorical language use signifies the incredible human ability to produce meaningful linguistic expressions that have never been heard before, coloring communication. This, however, may come at a price of increased comprehension costs in readers or listeners who need to integrate information from semantically distant concepts. Indeed, electrophysiological research has demonstrated that comprehending novel metaphors may be more effortful than literal language, but less effortful than nonsense language (e.g., Goldstein et al., 2012; Rataj et al., 2017; Rutter et al., 2012). Here, we set out to investigate if this processing effort may be modulated by prior experience and domain-specific knowledge. To this end, we collected EEG responses to literal, anomalous, and novel metaphorical sentences that were referring either to engineering knowledge or to general knowledge, testing engineering and non-engineering students.

Method

Participants: 22 engineers (11♀, 11♂) & 21 (13♀, 8♂) non-engineers | right-handed | monolingual English

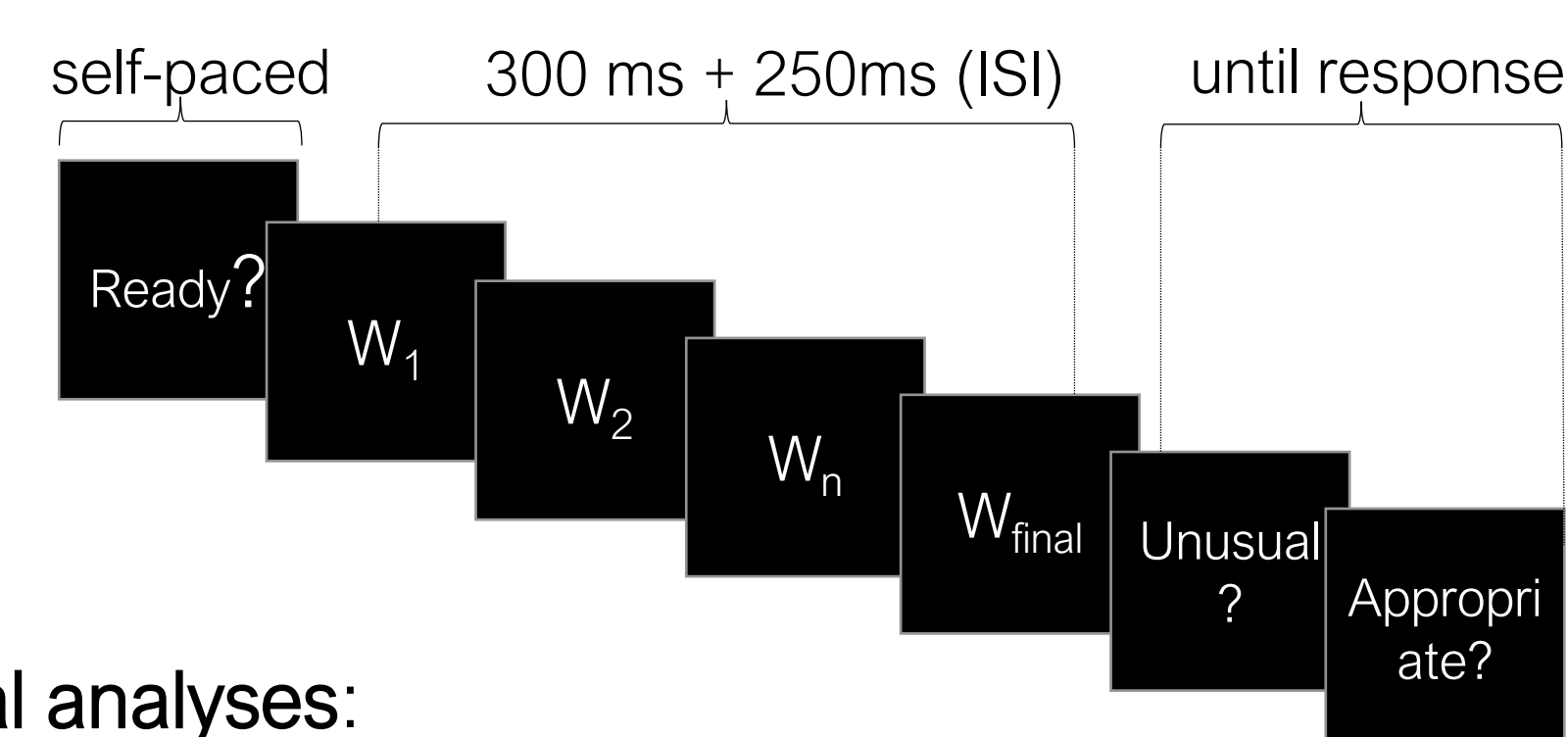
Stimuli: 228 English sentences, differing in verb only.

No	Type	Engineering items	General knowledge items
38	LIT	The wind <i>moved</i> the <u>turbine</u> .	The waves <i>flooded</i> the <u>beach</u> .
38	MET	The wind <i>tickled</i> the <u>turbine</u> .	The waves <i>drowned</i> the <u>beach</u> .
38	ANO	The wind <i>ate</i> the <u>turbine</u> .	The waves <i>excused</i> the <u>beach</u> .

- sentences referring to general knowledge were translations of Rutter et al.'s (2012) stimuli.
- all sentences were normed in 2 pre-experimental norming studies.
- ERPs were time-locked to the onset of the verb & the onset of the last word.

Task: Rapid Serial Visual Presentation (RSVP)

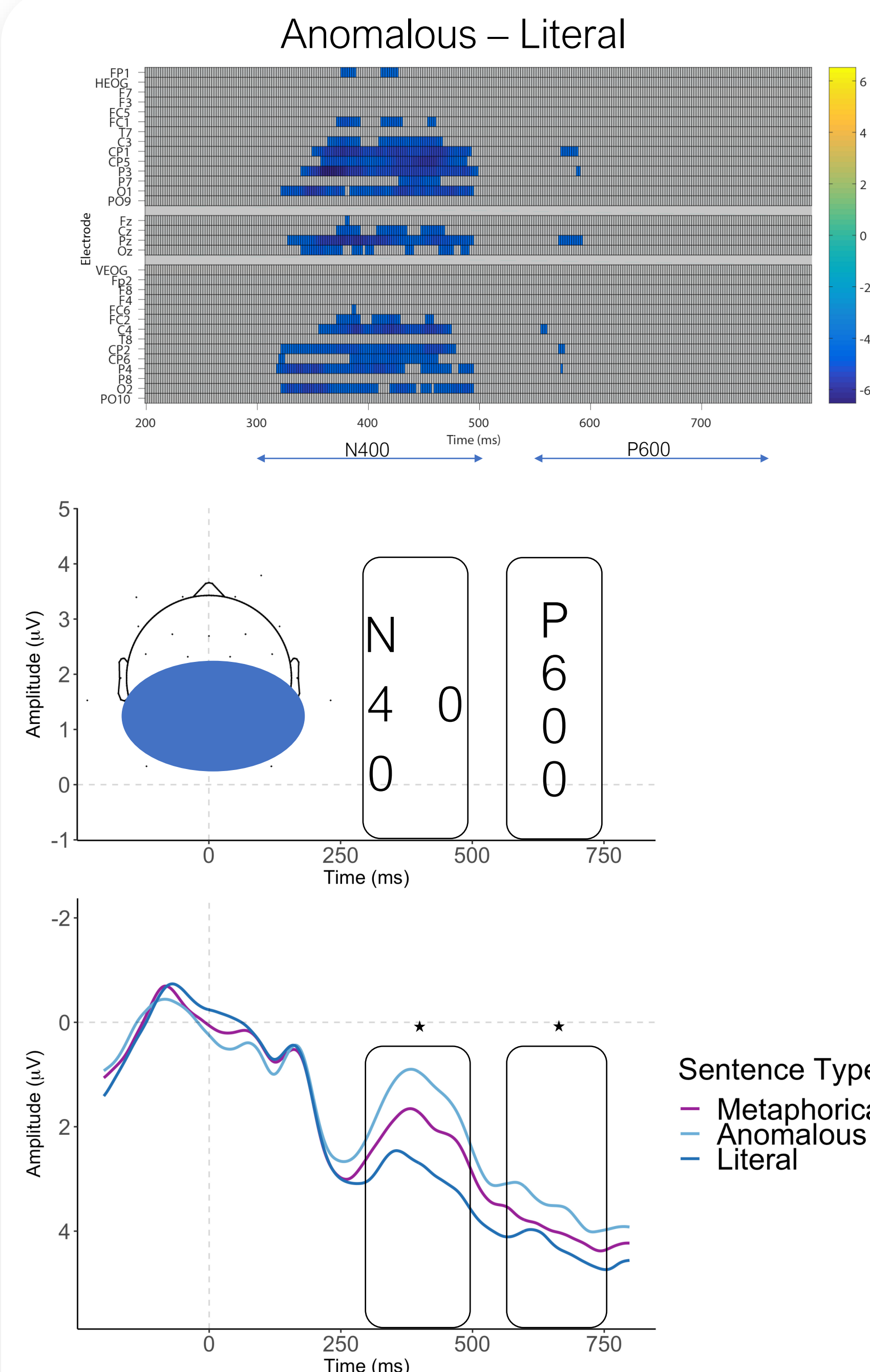
Following sentence presentation, participants judged if the meaning of the sentences was 1) unusual (original) and 2) appropriate (sensical).



Statistical analyses:

- AOV model: $N400/P600 \sim \text{Sentence} \times \text{ItemType} \times \text{Group} + \text{Error} (\text{Subject} / (\text{Sentence} \times \text{ItemType}))$
- Supplementary t-max permutation tests for the predicted planned comparisons
- to establish the timing and topography of the N400 and P600 for our data we ran a *t-max permutation test* on the difference between ERPs to *anomalous* and *literal* sentences (cf. Luck and Gaspelin 2017) using a Mass Univariate Analysis (Groppe et al. 2011)

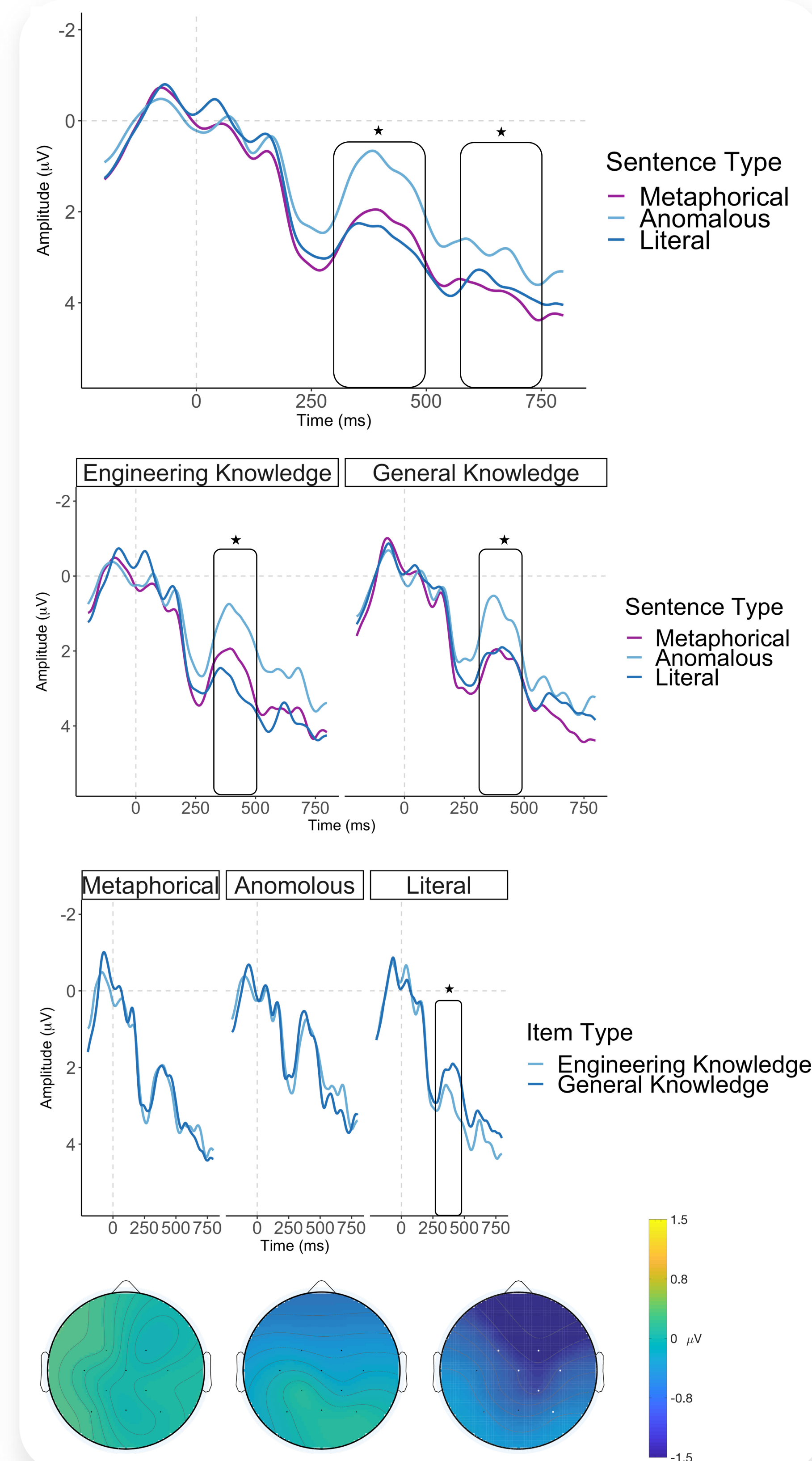
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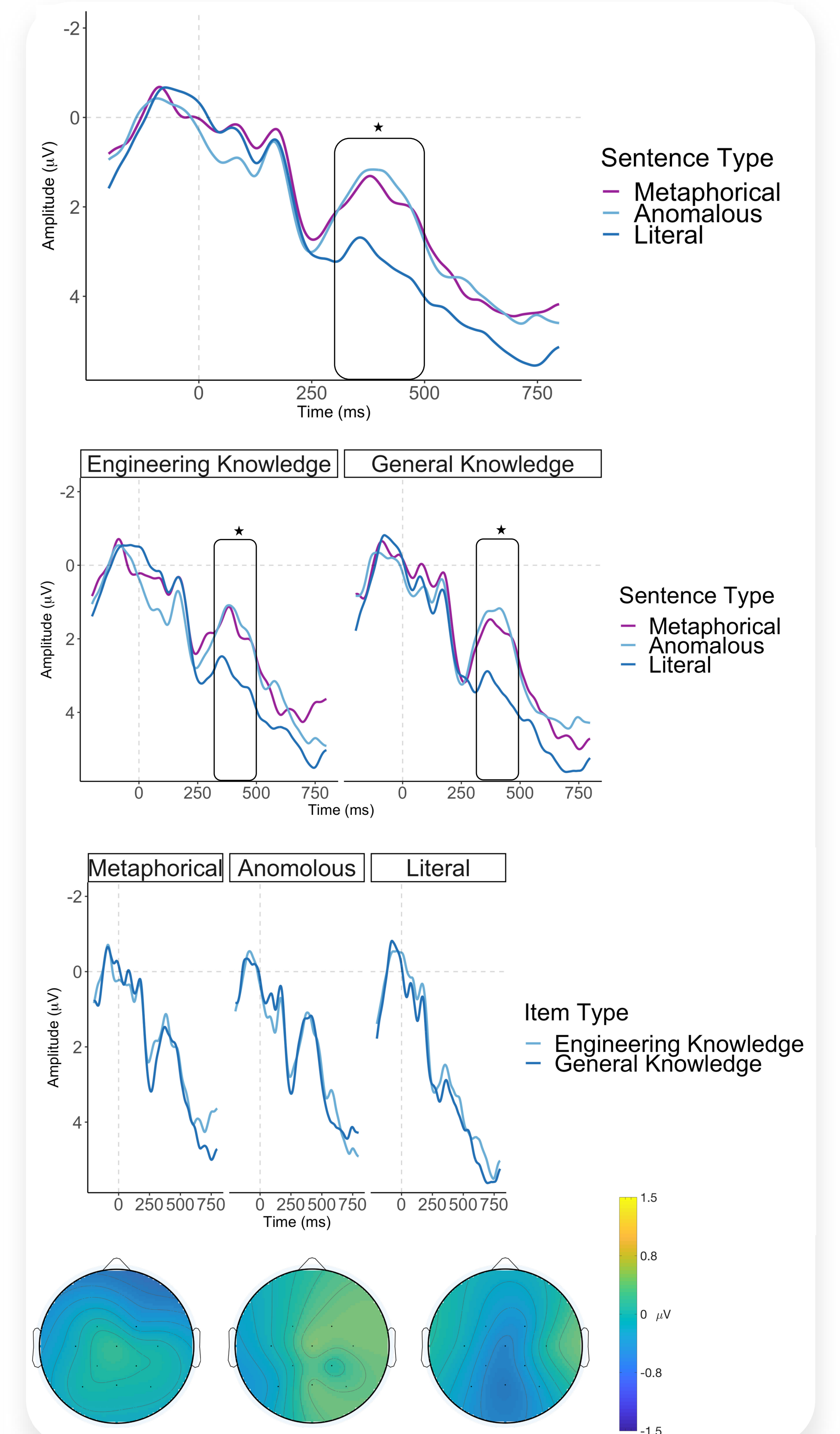
Results

***ERPs time-locked to final word onset

Engineering Students



Nonengineering students



Discussion

The present study corroborates prior work on novel metaphor processing, with increased N400 to nonsense sentences, followed by novel metaphors, and then literal sentences (cf., Rutter et al. 2012; Rataj et al. 2017). Notably, here novel metaphor comprehension is modulated by participants' expertise, with reduced N400 in engineers and increased N400 in nonengineers. Although both participant groups were insensitive to item manipulation (engineering vs. general knowledge) in the case of novel metaphors and anomalous sentences, engineers displayed reduced N400 to literal sentences related to engineering knowledge only. Altogether, our findings demonstrate group-level differences in the processing of metaphorical language, and a partial effect of domain-specific knowledge on the processing of literal sentences.

References

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