

Short-Reaching Prediction and Long-Reaching Integration in Response to Negative Polarity Items during Sentence Comprehension

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INTRODUCTION



- Sentence processing is incremental and may involve prediction at multiple linguistic levels [1].
- Negative polarity items (NPIs) form a dependency relation with their licenser that can be formalized at syntactic and semantic levels of description [2,3].
- ERPs are sensitive to on-line processing costs during NPI processing when they are unlicensed [4].
- What is unknown: Is active prediction involved?**
- German sentence structure allows some NPIs to precede their licenser at short or long distances, and thus provides a good testing ground for prediction and integration and the thereby incurred processing costs.
- We expected oscillatory and ERP correlates for prediction and integration to vary depending on distance between the NPI and its licenser.

- **Expected markers of prediction:** increased beta power indicating top-down predictions; gamma power indicating match with expectation [5].
- **Expected markers of integration:** N400 or anterior negativity [1,4,6].

RECORDING + ANALYSIS

- **Participants**
 - Healthy German-speaking adults (n = 32; 15 ♂)
 - Mean age: 23.4 (SD = 2.4) years
- **EEG-Recording**
 - 64-channel active electrode system (EasyCap equidistant M10 layout)
 - BrainVision BrainAmp amplifier system (sampling frequency 500Hz)
- EEG-Preprocessing:**
 - semi-automatic artefact rejection
 - high-pass filtered at 0.3 Hz, low-pass filtered at 100 Hz
 - removal of microsaccades using *costrap* algorithm [7]
 - notch filter to reduce line noise at 50 Hz
 - automatic ICA-based removal of eye and muscle artefacts (*SASICA+ADJUST* algorithms) [8,9]
 - re-referencing to averaged mastoids
 - cut epochs (ERP: onset of negation [-0.2s, 1.2 s], TF: onset of second sentence [-2.1s, 5.8 s])
- **ERP Analysis**
 - Signal averaging with baseline -200 – 0 s relative to negation onset
 - CBPTs 0.1. – 0.800s on negation (p<.05)
- **Time-Frequency-Analysis:**
 - Wavelet analysis (wavelet width = 12, 80 logarithmically spaced frequency bins between 5 Hz – 80 Hz)
 - Baseline -1.7 – -0.9 s (period during context sentence)
 - Selection of frequency bands based on condition-independent visual inspection and hypotheses
- **Statistics:**
 - Cluster-based permutation tests (p <. 05) for
 - i) ERPs at negation positions (i.e. integration points).
 - ii) TF-Data in prediction intervals and negation positions.
 - Comparisons of early and late negation sentences with NPIs vs. nonPIs.

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MATERIALS & TASK

Table 1: Scenario types, example sentences and mean naturalness ratings (on a 1-7 Likert scale (1 = unnatural, 7 = natural))

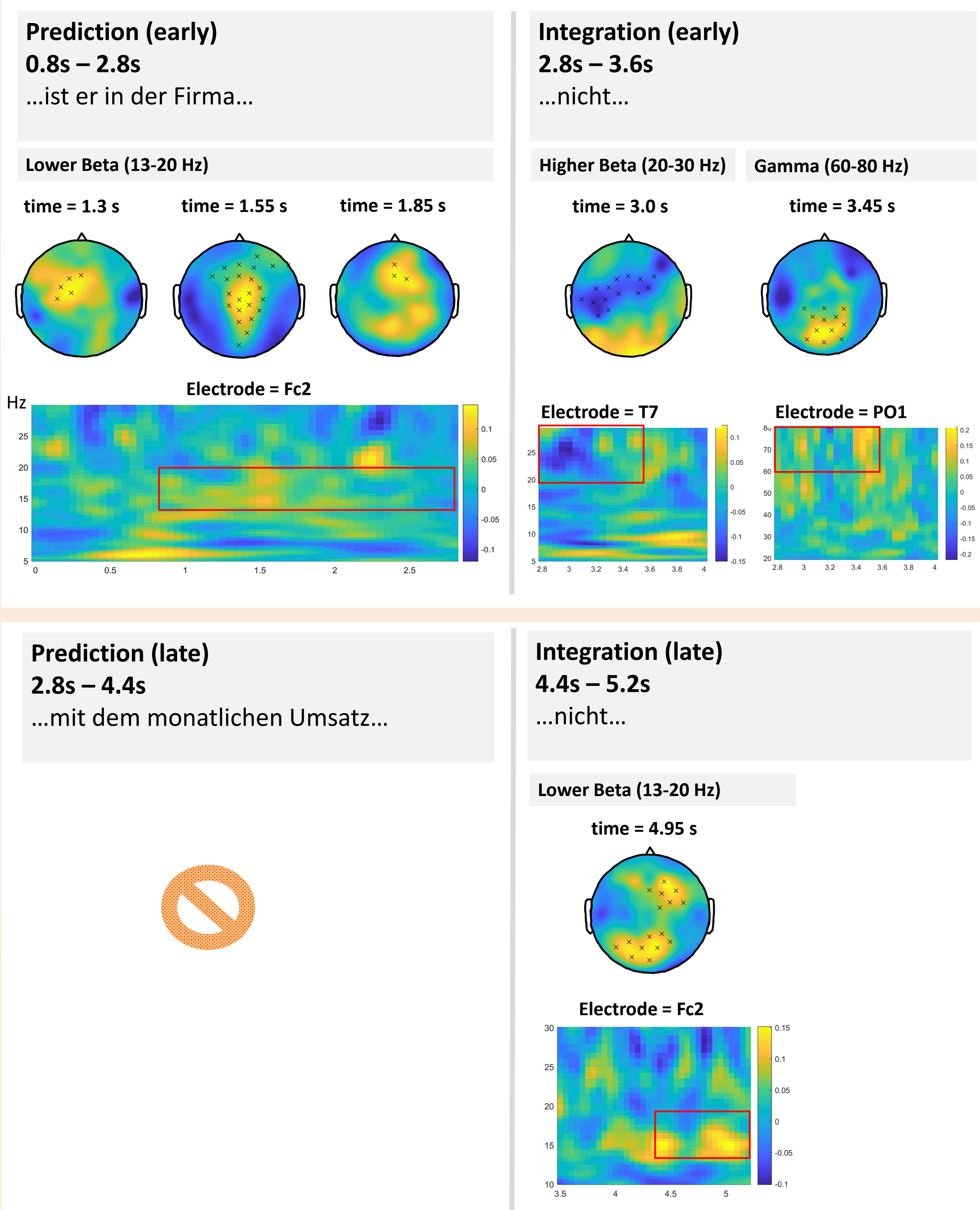
Scenario type	Example	Mean naturalness rating
Target context sentence	Holger hat letztes Jahr einen eigenen Betrieb gegründet. 'Holger has founded his own business last year.'	
A. NPI + late negation	So recht ist er in der Firma mit dem monatlichen Umsatz nicht zufrieden. 'He is not really satisfied with the monthly revenue of the company.'	5.44 (0.93)
B. nonPI + late negation	Sehr häufig ist er in der Firma mit dem monatlichen Umsatz nicht zufrieden. 'He is not satisfied very often with the monthly revenue of the company.'	5.19 (0.96)
C. NPI + early negation	So recht ist er in der Firma nicht mit dem monatlichen Umsatz zufrieden. 'He is not really satisfied with the monthly revenue of the company.'	5.34 (0.90)
D. nonPI + early negation	Sehr häufig ist er in der Firma nicht mit dem monatlichen Umsatz zufrieden. 'He is not satisfied very often with the monthly revenue of the company.'	5.06 (0.95)

- Two sessions per participant
- 40 scenarios per condition + 160 fillers
- Pseudo-randomized presentation across 2 sessions
- Rapid serial visual presentation word-by-word (400ms for each word, no ISI, 800 ms for last word).
- Fixation cross for 1500ms before each scenario.
- Irregular comprehension questions to ensure attention.

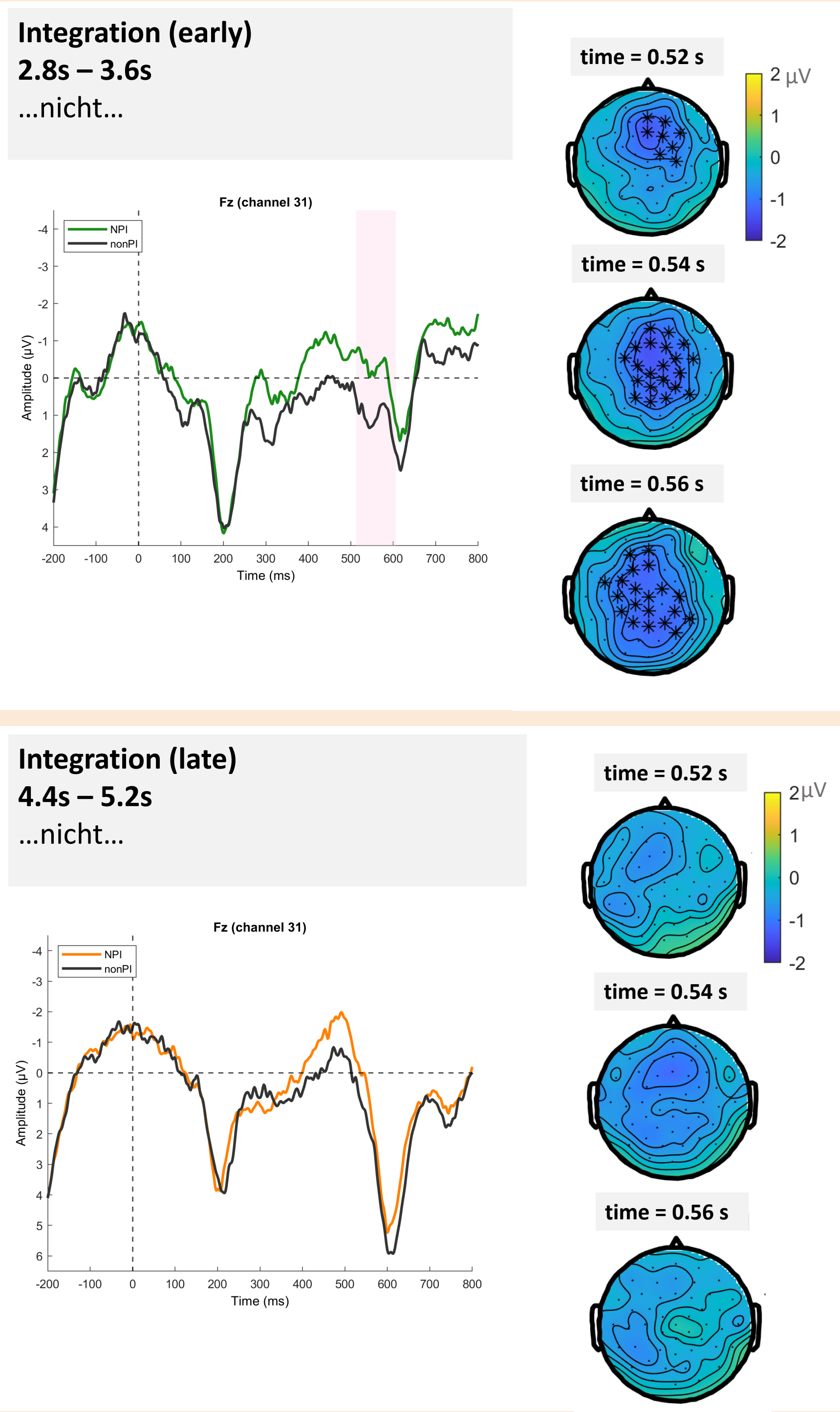
RESULTS

Example sentence (A)/(B)	So recht /sehr häufig ist er in der Firma mit dem monatlichen Umsatz nicht zufrieden.
Analysis phases	... Prediction (early) Prediction late) Integration (late)
Example sentence (C) /(D)	So recht/sehr häufig ist er in der Firma nicht mit dem monatlichen Umsatz zufrieden.
Analysis phases	... Prediction (early) Integration (early)

Time-Frequency Analysis



ERP Analysis



DISCUSSION

➤ Predictions may sometimes reach only short!

- Early in the sentence NPI sentences go along with increased beta power. Consistent with views that assign the role of pre-activation of specific linguistic information to the beta band [5]. In later period no evidence for active prediction is found anymore:

➤ Integration effects are modulated by distance/prediction!

- Early negations:** Decreased beta and higher gamma indicate update of prediction and match with expectation [5]. Negative ERP may indicate prediction error processing in general [1] or integration of linguistic dependency [4,6].
- Late negations:** Increased beta may indicate re-activation of the previous content (i.e. NPI) in order to integrate it with the negation [10].