



Neural encoding of linguistic features during natural sentence reading

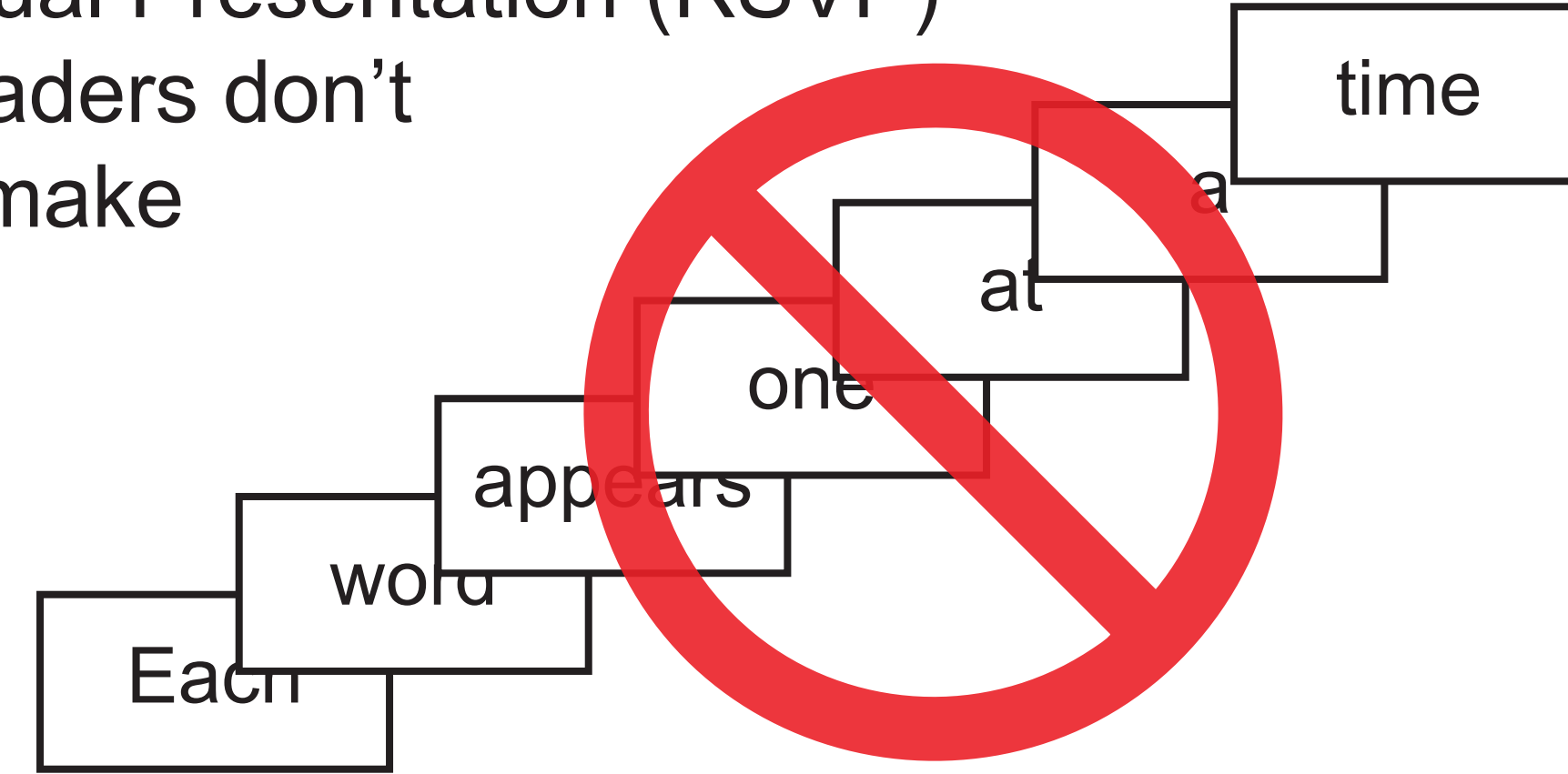
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Introduction

Rapid Serial Visual Presentation (RSVP) is unnatural! Readers don't control pace or make eye movements



Fixation-Related Potentials (FRPs) compare few conditions and can be confounded by overlapping eye movements¹

We use Temporal Response Functions (TRFs) to measure EEG responses to language features of words around fixation during sentence reading with eye movements.

We find...

- Speech-related encoding is time-locked to fixation and lags behind the fixated word
- Contextual encoding occurs in a window around fixation and correlates with reading time
- Results support the interactive account of reading

Methods

ZuCo 1.0² & 2.0³ Datasets

- 29 participants completed 41 sessions
- Each 300-400 sentences (19.6 ± 9.4 words)
- Movie reviews and English Wikipedia articles
- 105ch scalp EEG + eye-tracking (~26.5 hrs total)

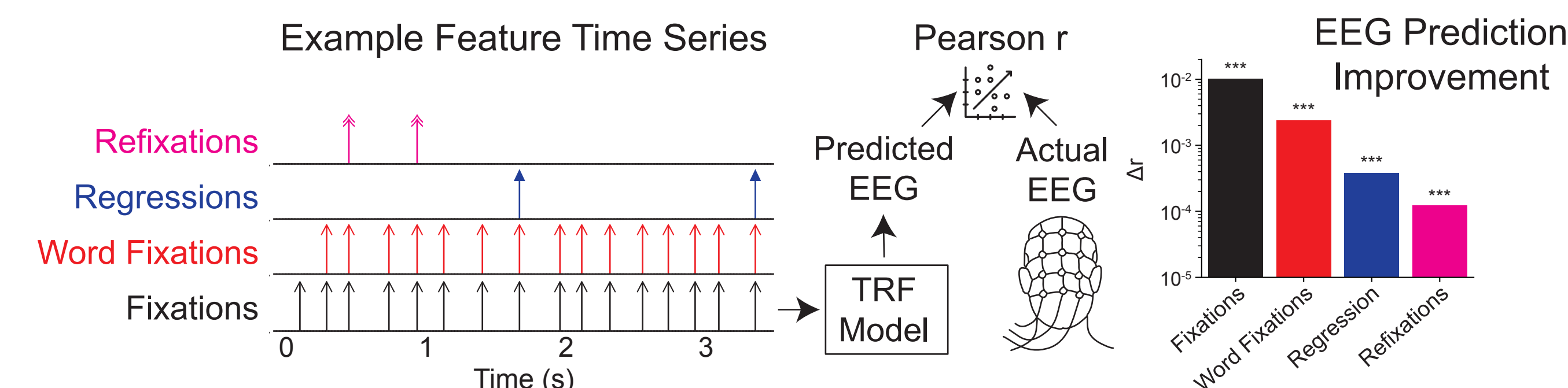
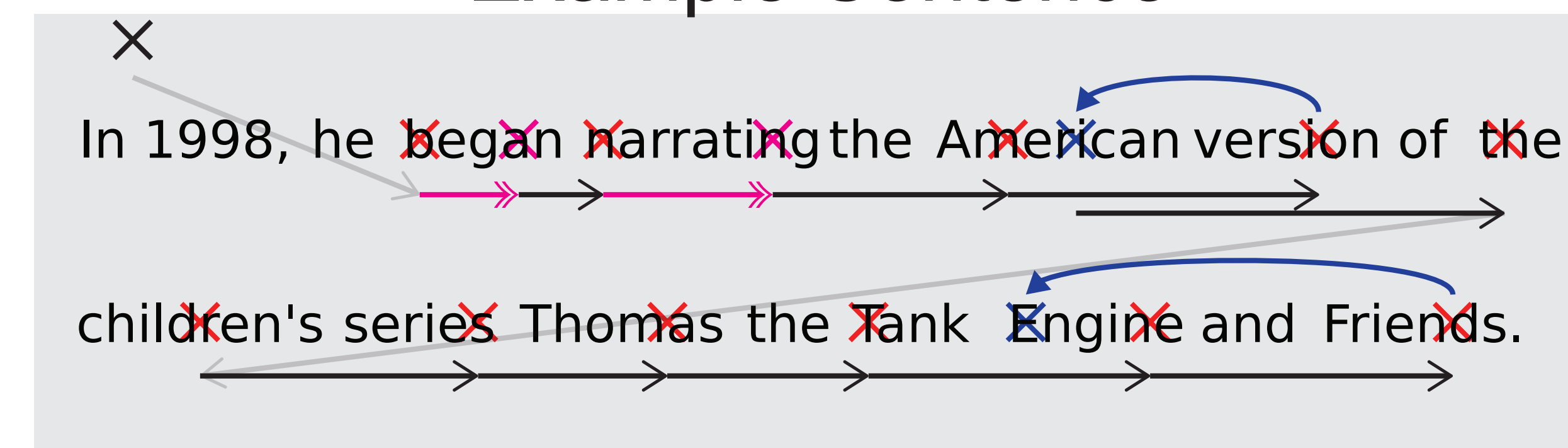
All features locked to fixation

- Reading-related fixations
 - Word fixations, regressions, refixations
- Linguistic features (example: "series")

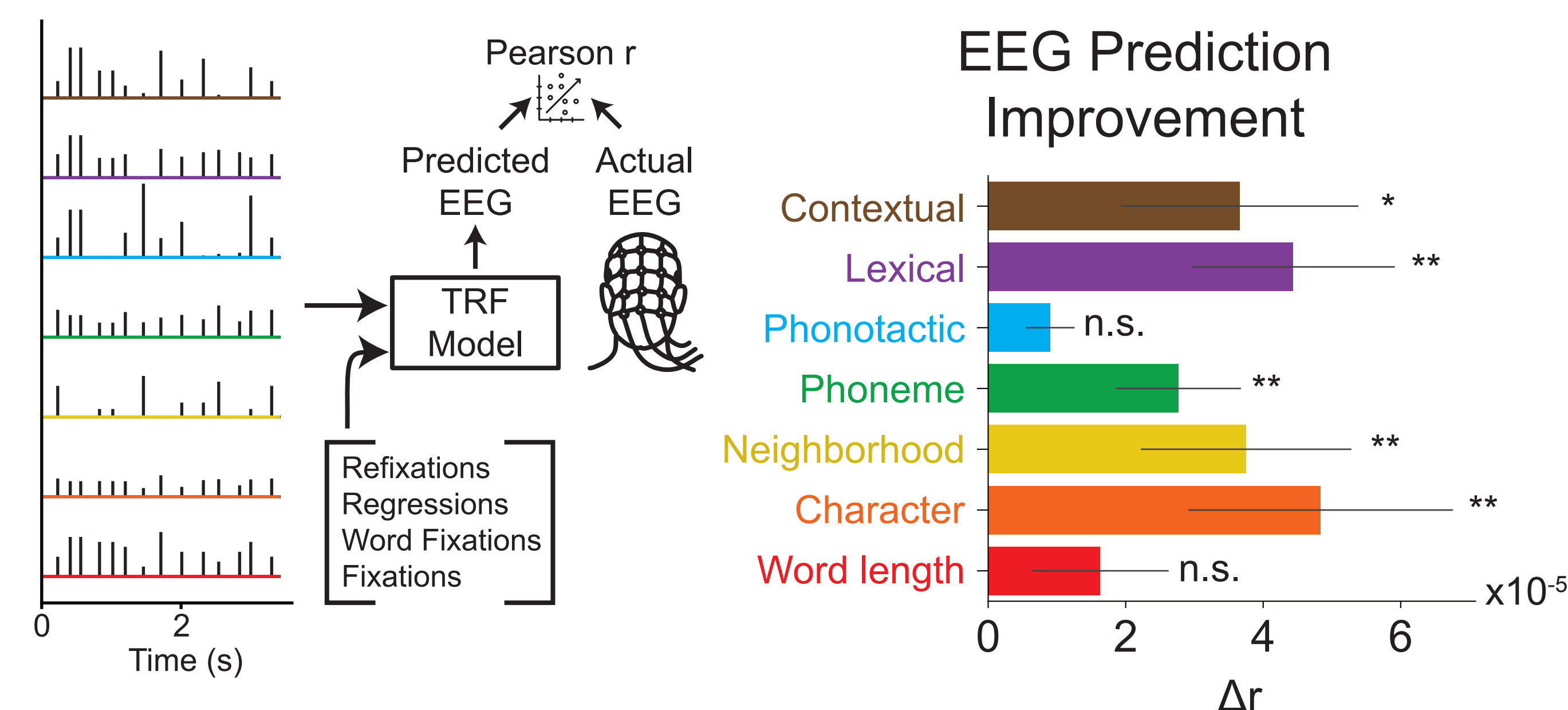
Semantic	Contextual surprisal	...of the children's series
	Lexical surprisal	series
Phonologic	Phonotactic surprisal	/s ih r iy z/
	Phoneme surprisal	/s/, /ih/, /r/, /iy/, /z/
Orthographic	Neighborhood size	aeries, serves, serifs, etc.
	Character surprisal	S, E, R, I, E, S
	Word length	■■■■■■■

Reading-Related Fixations

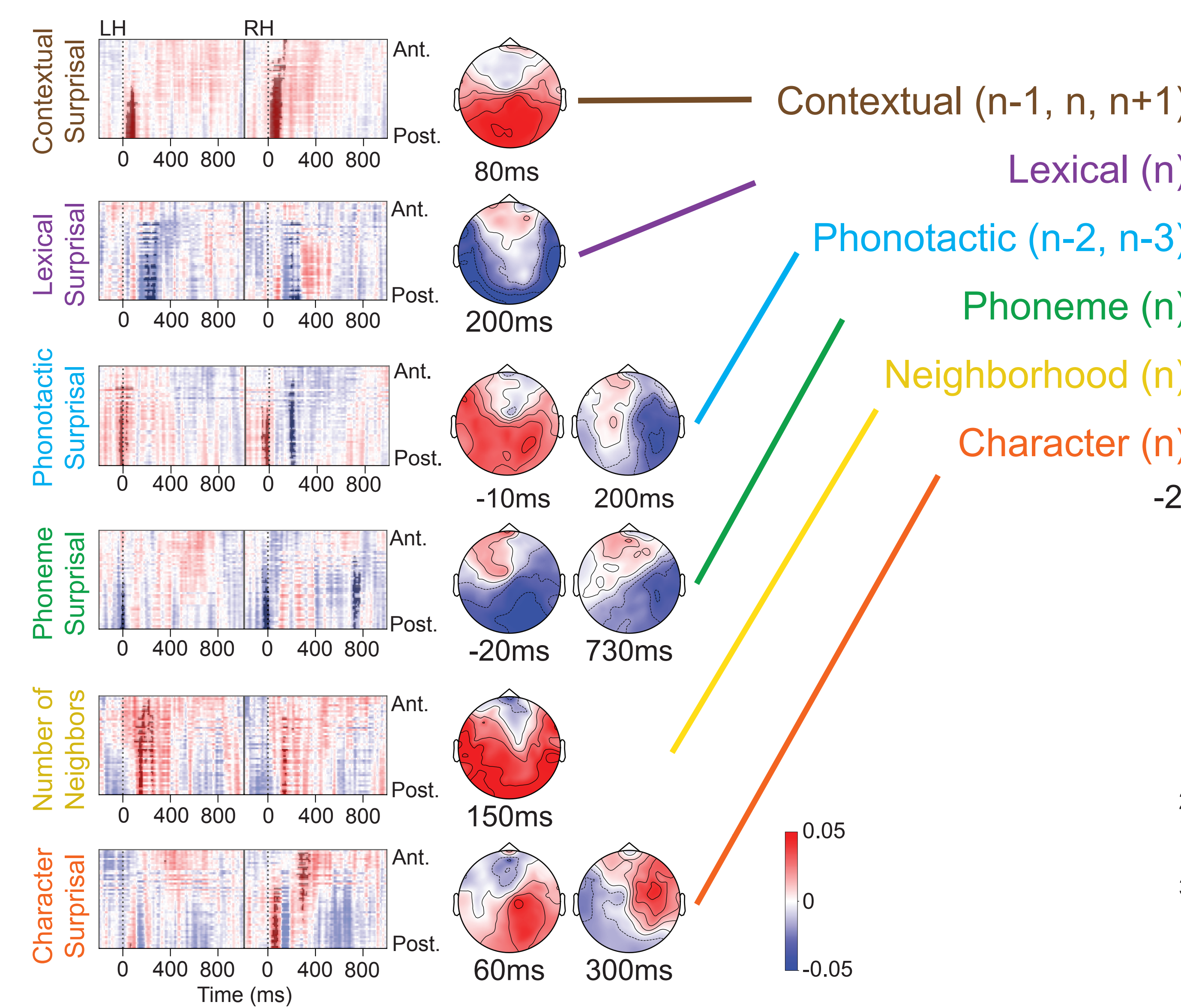
Example Sentence



Linguistic Encoding at Fixation

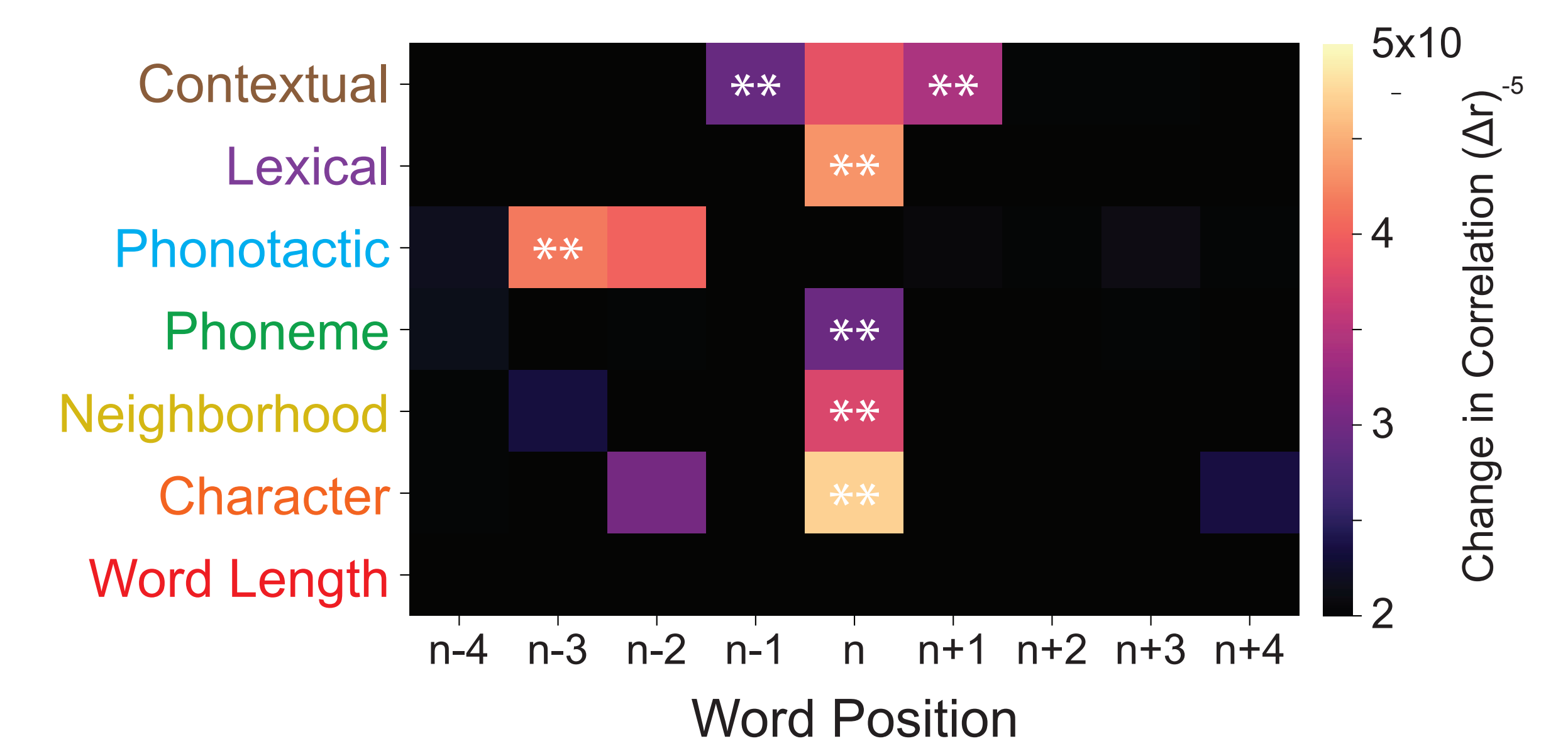
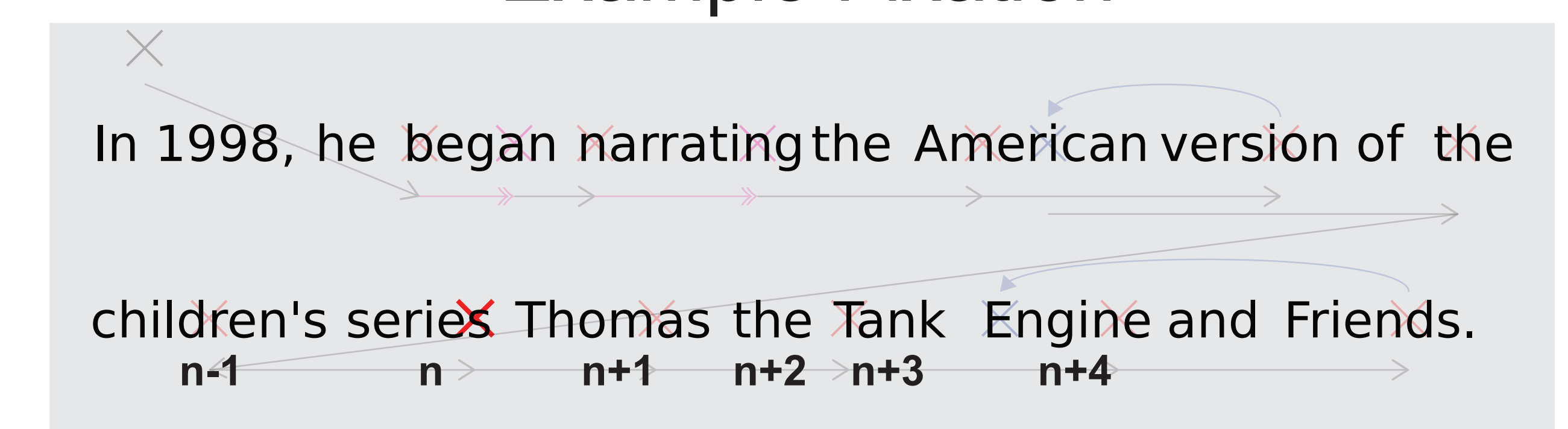


Linguistic Feature TRFs

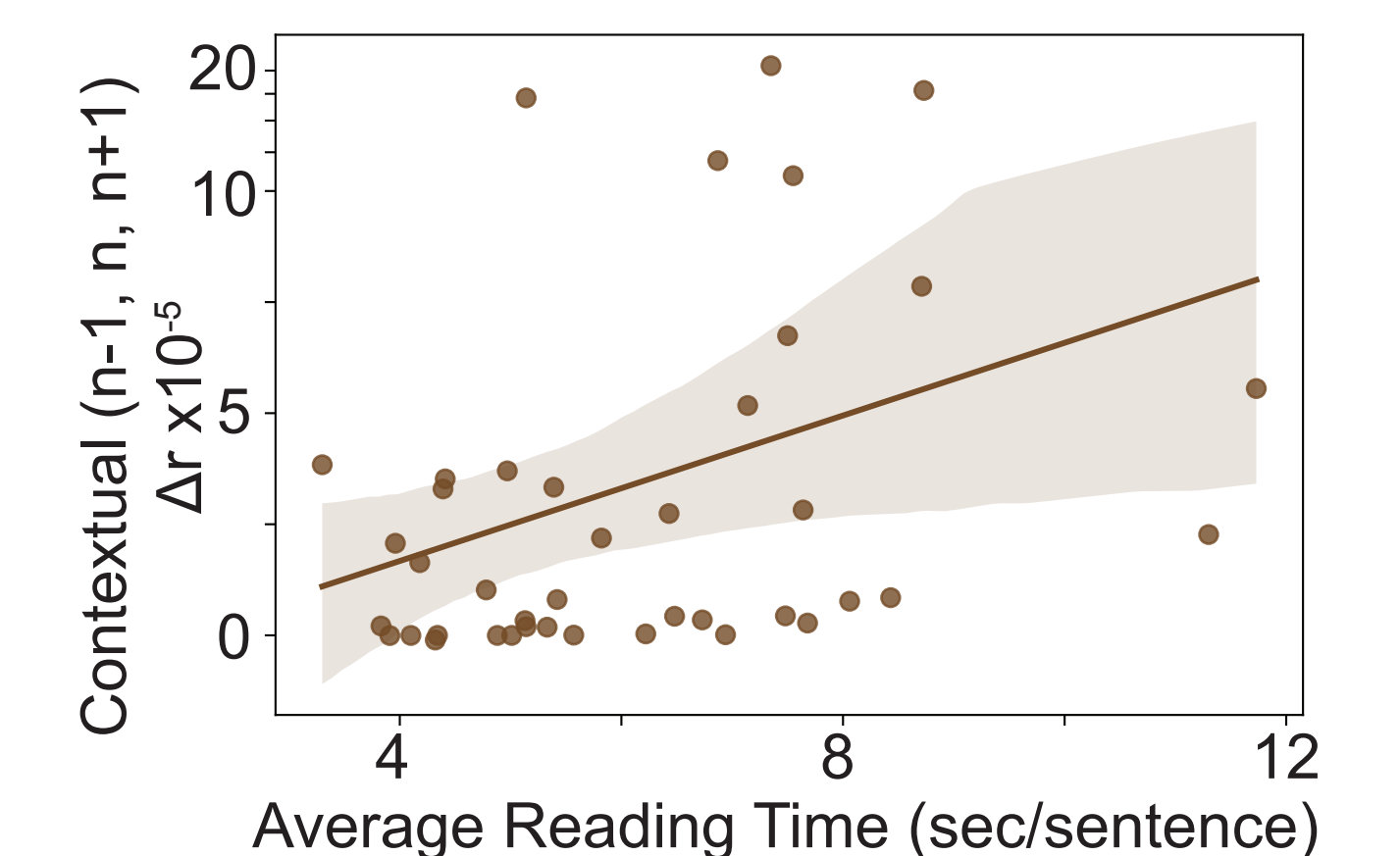


Encoding Around Fixation

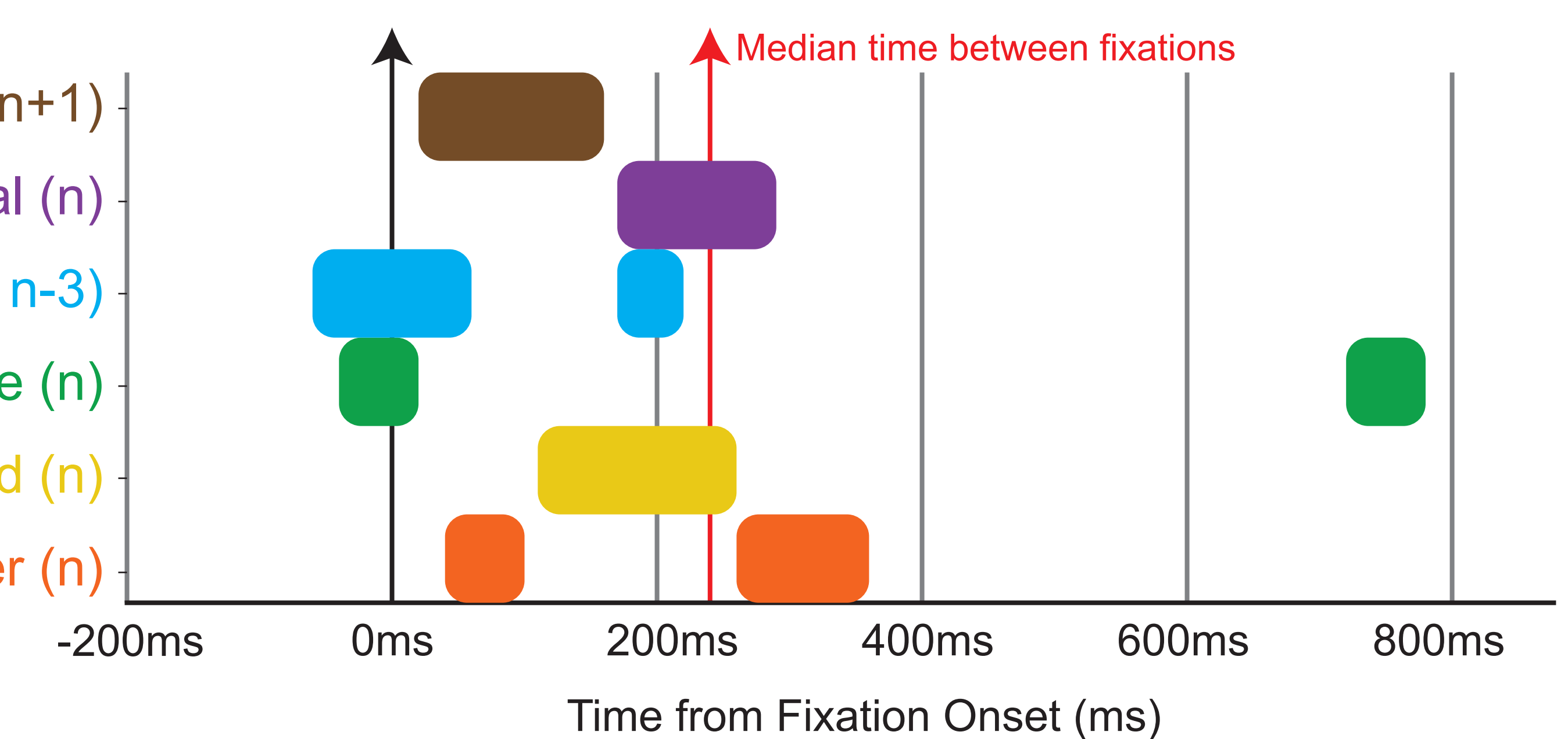
Example Fixation



Contextual Encoding Around Fixation Correlates with Reading Time



Summary of Encoding at Fixation



References

1. Dimigen, O., & Ehinger, B. V. (2021). Regression-based analysis of combined EEG and eye-tracking data: Theory and applications. *Journal of vision*, 21(1), 3-3.
2. Hollenstein, N., Rotsztein, J., Troendle, M., Pedroni, A., Zhang, C., & Langer, N. (2018). ZuCo, a simultaneous EEG and eye-tracking resource for natural sentence reading. *Scientific data*, 5(1), 1-13.
3. Hollenstein, N., Troendle, M., Zhang, C., & Langer, N. (2019). ZuCo 2.0: A dataset of physiological recordings during natural reading and annotation. *arXiv preprint arXiv:1912.00903*.

Paper

