

Prosodic Entrainment Influences Syntactic Phrase Generation

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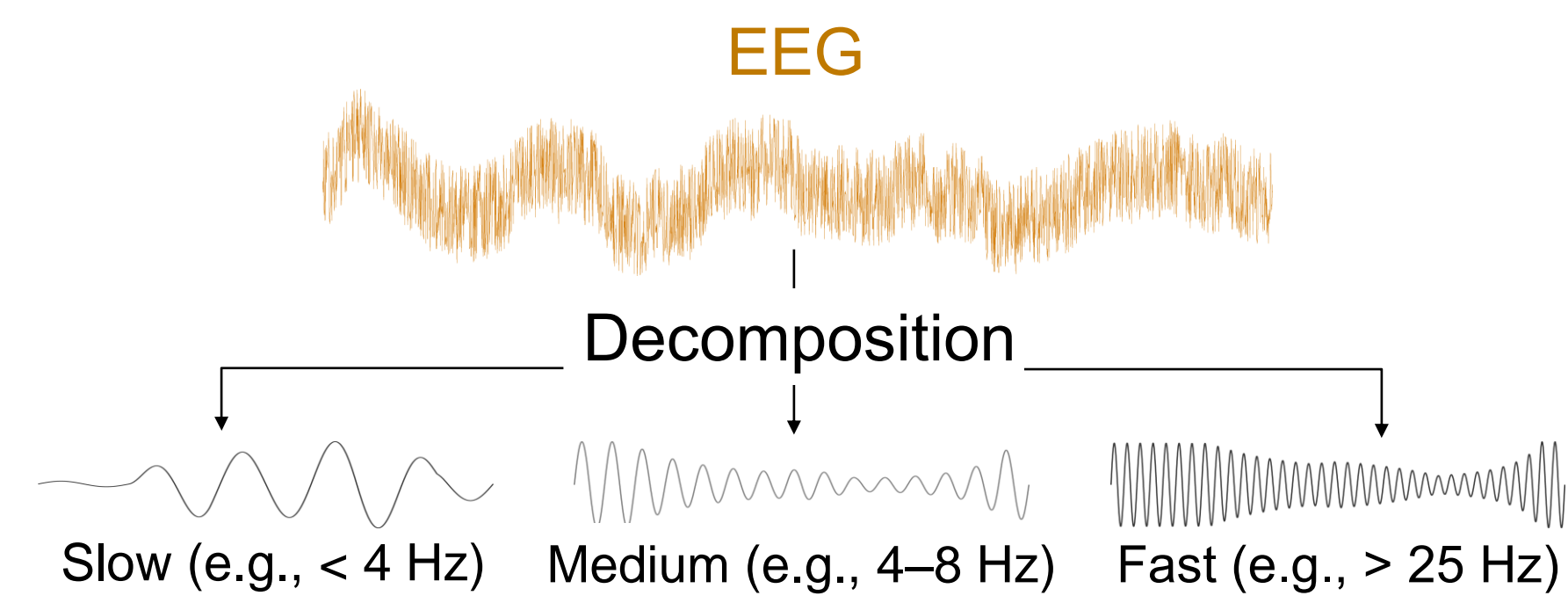
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Introduction

Prosody and segmentation

- Sentence chunking depends on prosodic rhythm
- Previously demonstrated prosodic rhythm can influence your chunking of a sentence without prosody (Steinhauer and Friederici, 2001)
- Prosodic contour is thought to be tracked by **delta**-oscillations in the brain with frequency < 4 Hz (Bourguignon et al., 2013, Meyer et al., 2017, etc.)

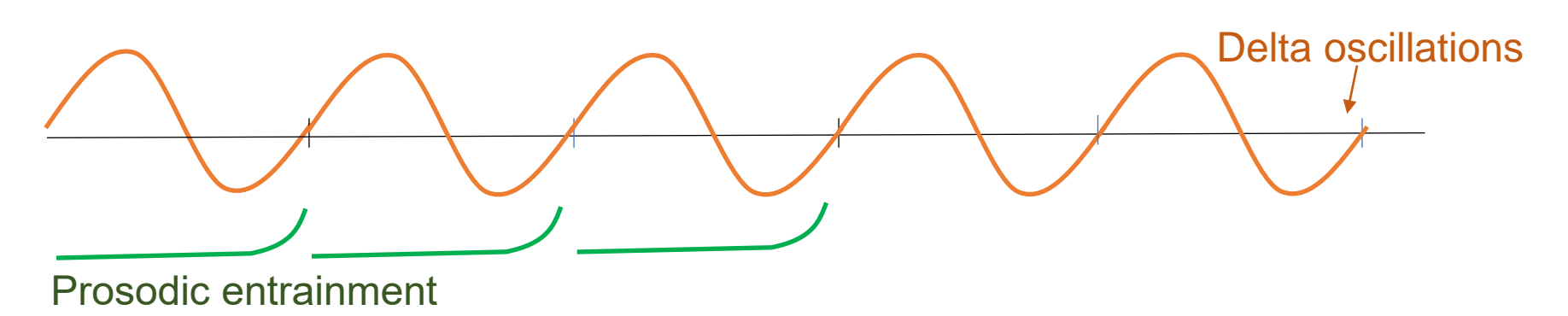
Oscillations in brain



- Oscillations in brain - periodic fluctuations in charge-discharge cycle in neuronal ensembles;
- Different **wavelengths** - different operation **frequencies**;
- Keep their period at least for a couple of cycles;
- **Processing in brain can be periodic rather than discrete**

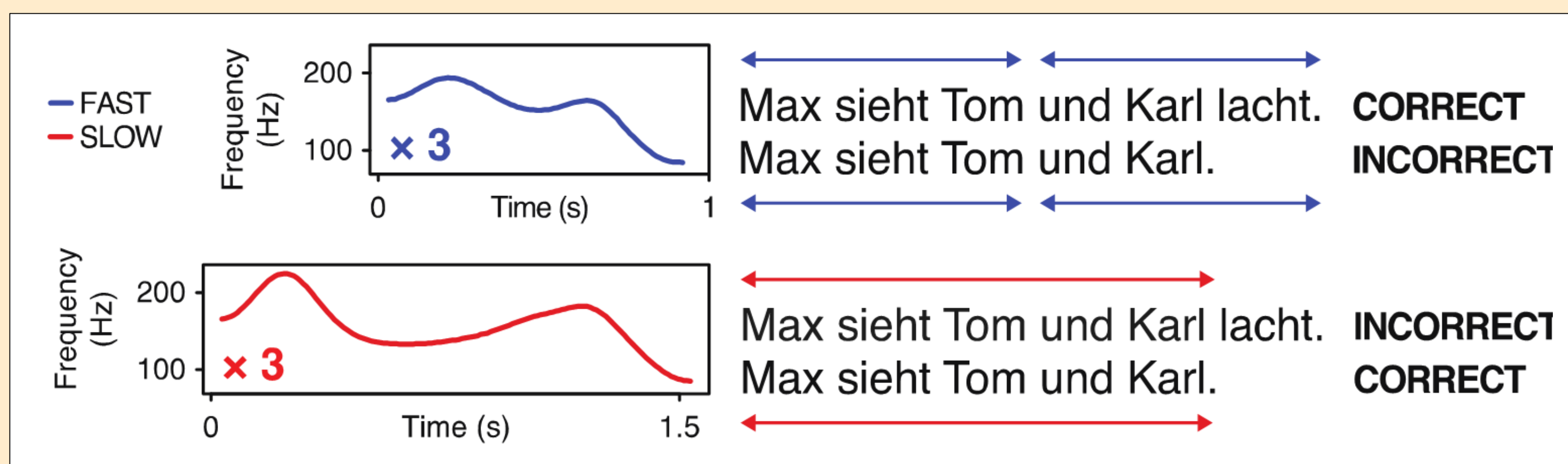
Prosodic entrainment via oscillations

- Prosody may affect sentence segmentation through oscillations
- In order to prove that this is really an oscillation, we should be able to entrain it
- **Entraining** an oscillation - setting it to a particular frequency/phase by preceding repeating stimuli:



- **Is it possible to entrain a specific prosodic length, which would further affect sentence comprehension?**

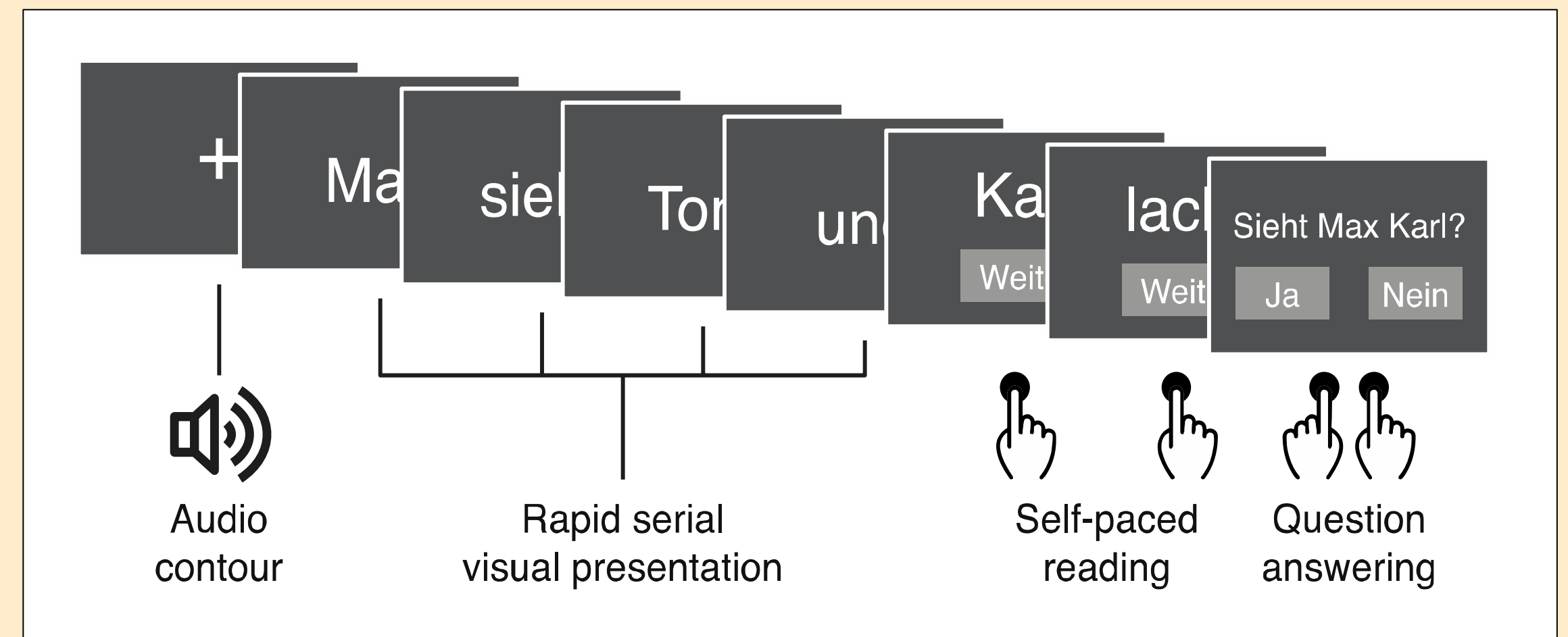
Paradigm



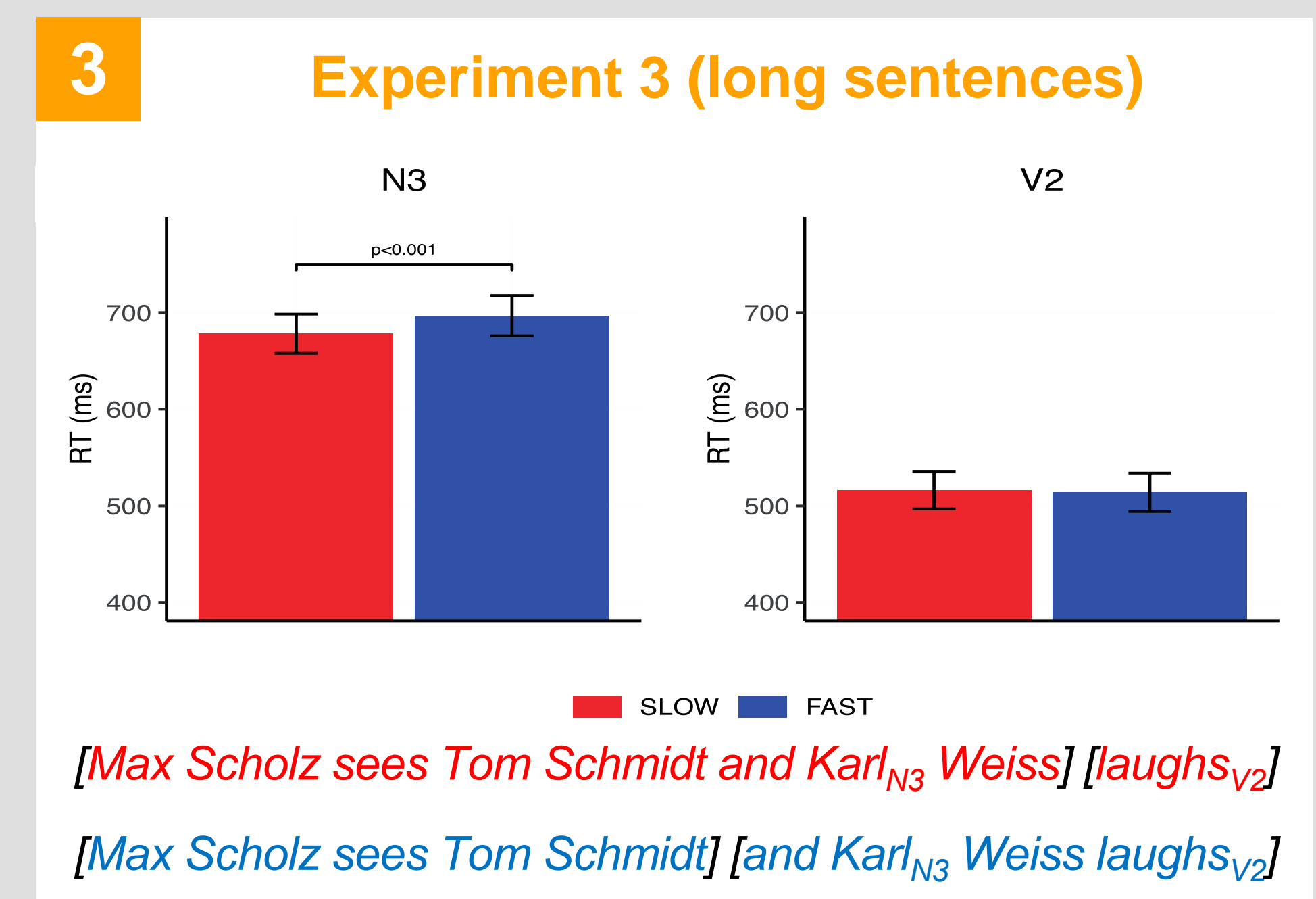
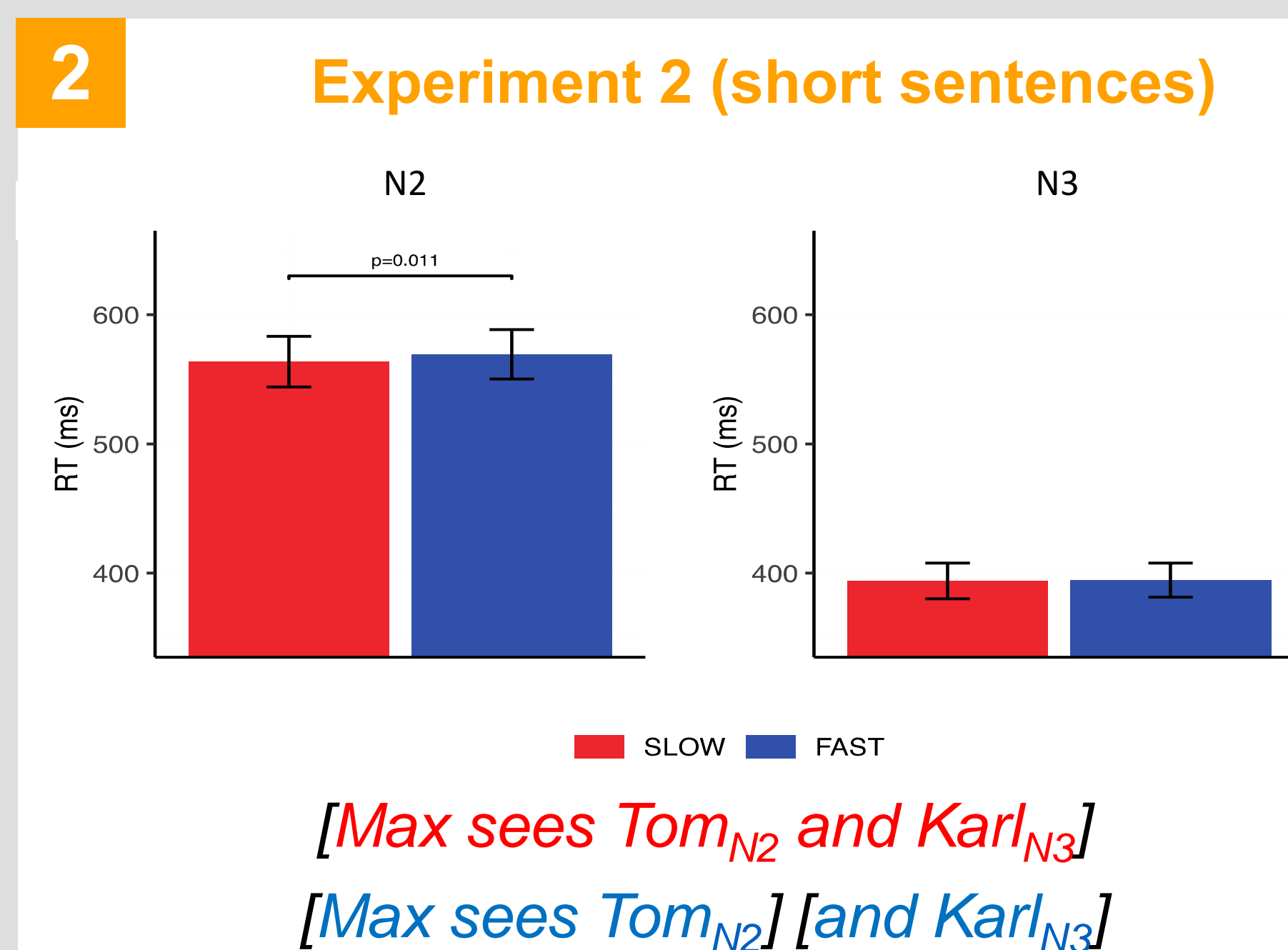
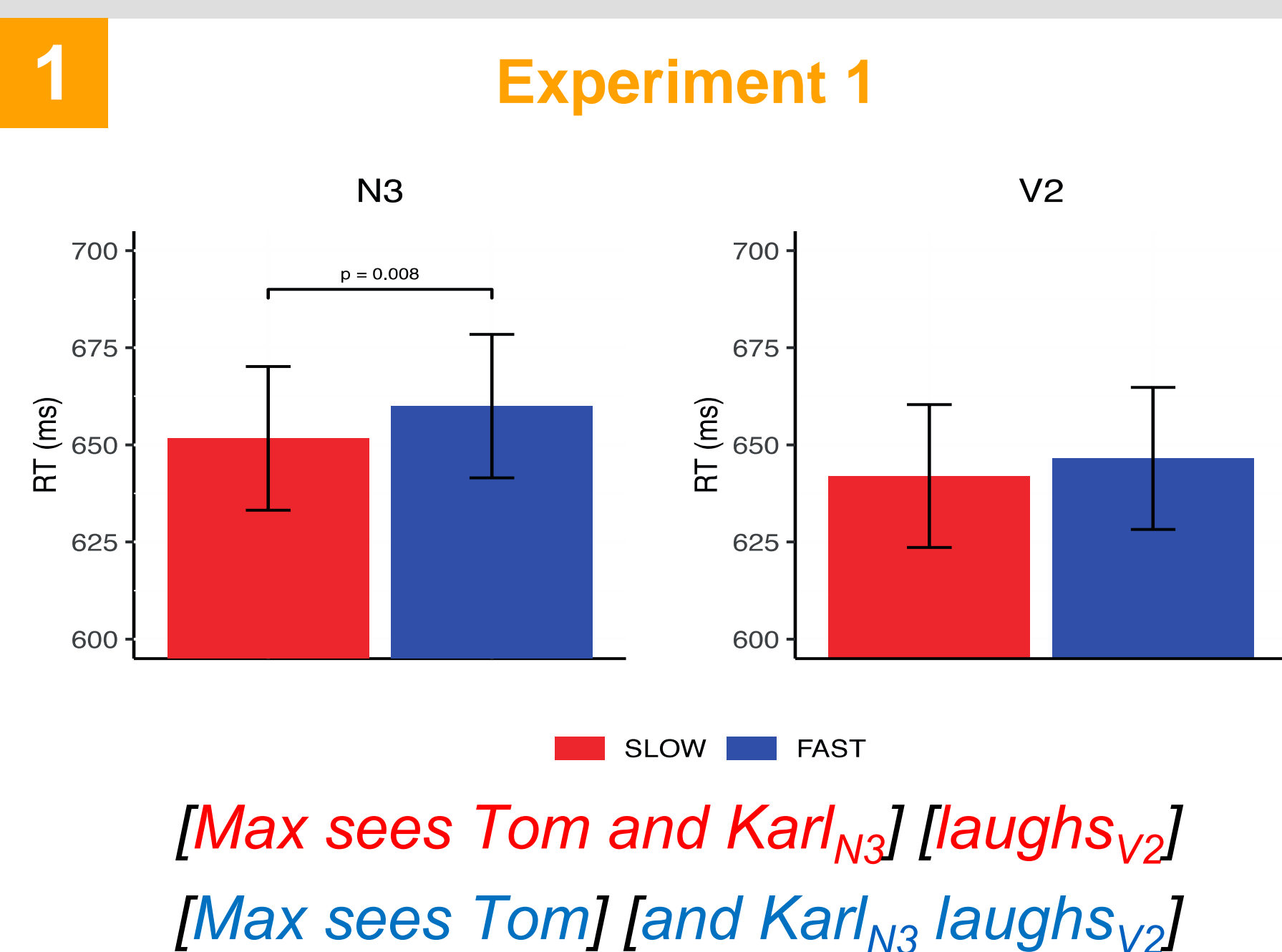
- Prosodic contour **repeated 3 times** to induce entrainment, followed by time-matched **RSVP** presentation of the sentence.
- **Fast entrainment** (short contour) induces correct chunking of **long** sentences, but incorrect in case of **short** sentences.
- **Slow entrainment** (long contour), on the contrary, induces correct chunking of **short** sentences, but incorrect in case of **long** sentences (so-called “garden-path effect”).

Procedure

- 3 consecutive experiments with different sentence length (shorter in Experiment 2 and longer in Experiment 3)
- Experiments conducted online with 80 participants each
- Data analysis: RTs for the self-paced words; linear mixed modelling (lme4 package in R)



Results



Discussion

Results consistent with **temporal prediction** account of delta band

- subjects respond faster to stimuli at the end of **predicted temporal intervals** (the RTs correlate with the phase of the delta band oscillation)

Current study:

- 1) Participants always expect a **longer** sentence
- 2) **Long sentence expectation strengthened by SLOW entrainment /weakened by FAST:** shorter RT at N3 – subjects expecting continuation of the sentence
- 3) Effect increased with the sentence length (comparison across 3 experiments)

Conclusions:

- It is possible to **entrain** a prosodic contour;
- Prosodic entrainment influences our linguistic perception in a **predictive** fashion;
- The internal mechanism of this phenomenon may be linked to **delta-band oscillations**.

Revisiting prosodic functions:

- (a) prosody and IPBs (intonational phrase boundaries) facilitate bottom-up chunking;
- (b) prosody helps the listener to anticipate the length of the upcoming constituent, potentially via neural entrainment.

References

- Bourguignon, M., De Tiege, X., de Beeck, M. O., Liot, N., Paquier, P., Van Bogaert, P., ... & Jousmäki, V. (2013). The pace of prosodic phrasing couples the listener's cortex to the reader's voice. *Human brain mapping*, 34(2), 314-326.
- Meyer, L., Henry, M. J., Gaston, P., Schmuck, N., & Friederici, A. D. (2017). Linguistic bias modulates interpretation of speech via neural delta-band oscillations. *Cerebral Cortex*, 27(9), 4293-4302.
- Steinhauer, K., & Friederici, A. D. (2001). Prosodic Boundaries, Comma Rules, and Brain Responses: The Closure Positive Shift in ERPs as a Universal Marker for Prosodic Phrasing in Listeners and Readers. *Journal of Psycholinguistic Research*, 30(3), 267-295.