

Prosodic Entrainment Influences Syntactic Phrase Generation

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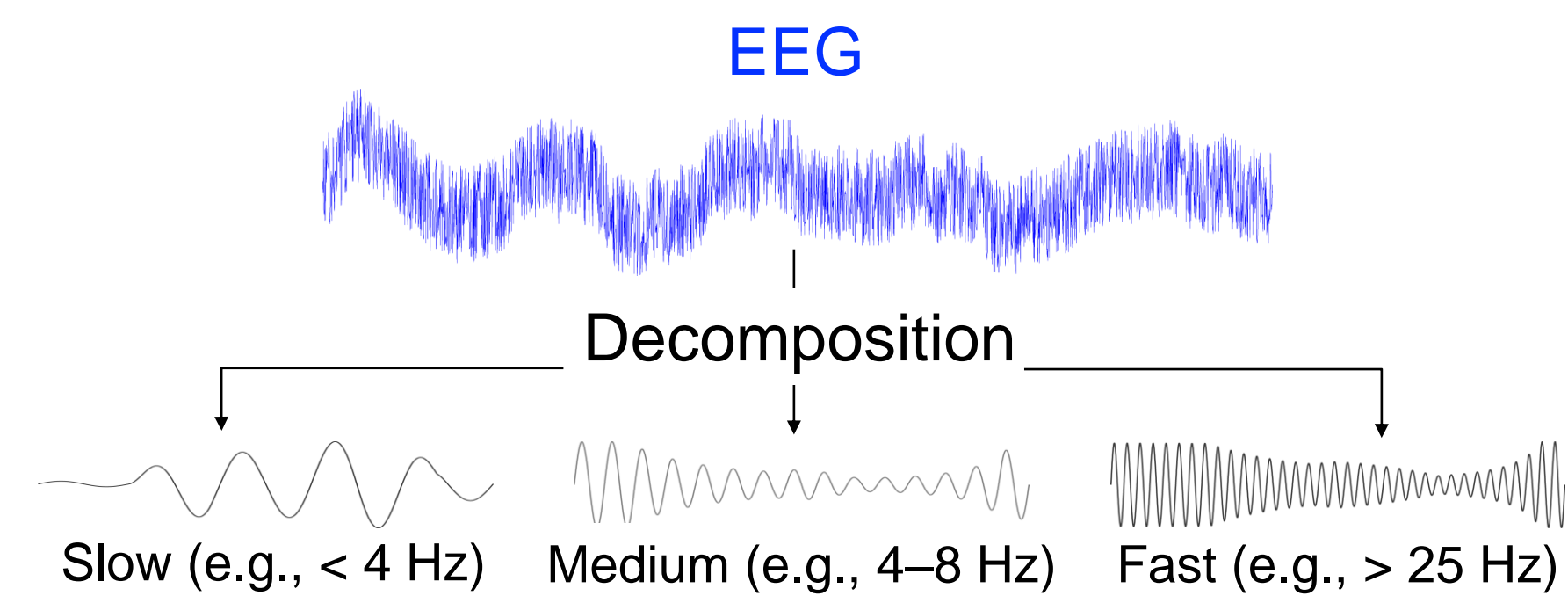
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Introduction

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.)

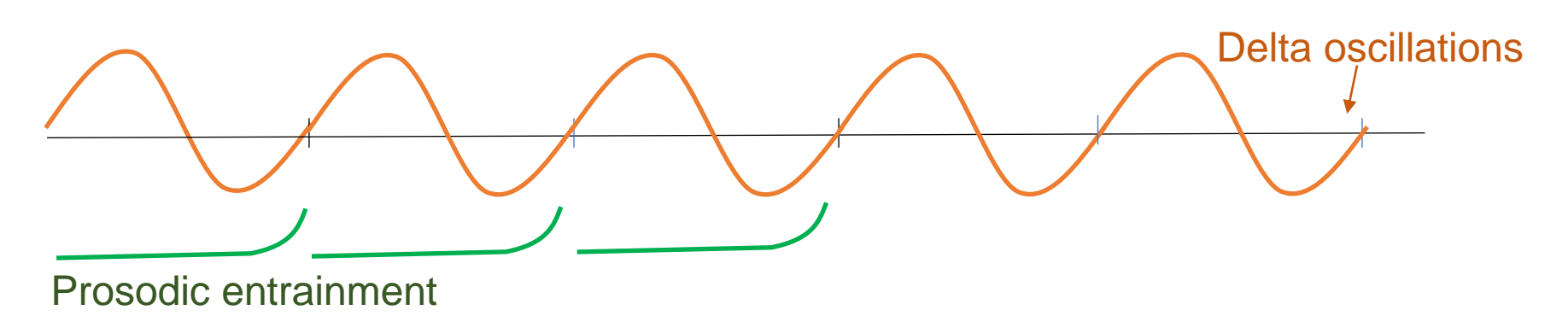
Oscillations in brain



- 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

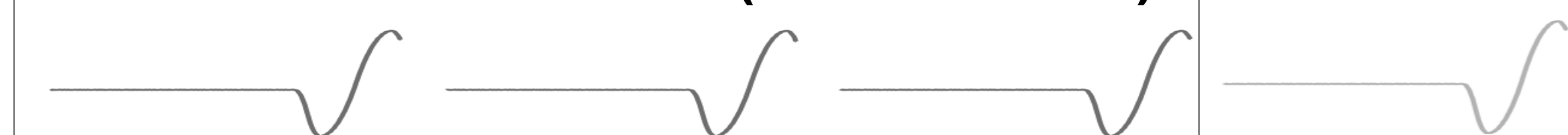
- Prosody may affect sentence segmentation through oscillations
- In order to prove that this is really an oscillation, we should be able to entrain it
- Entraining** an oscillation - setting it to a particular frequency/phase by preceding repeating stimuli:



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

Paradigm

FAST ENTRAINMENT (PITCH TRACK)



2 clauses Max sees Tom and Karl laughs.
1 clause Max sees Tom and Karl.

SLOW ENTRAINMENT (PITCH TRACK)



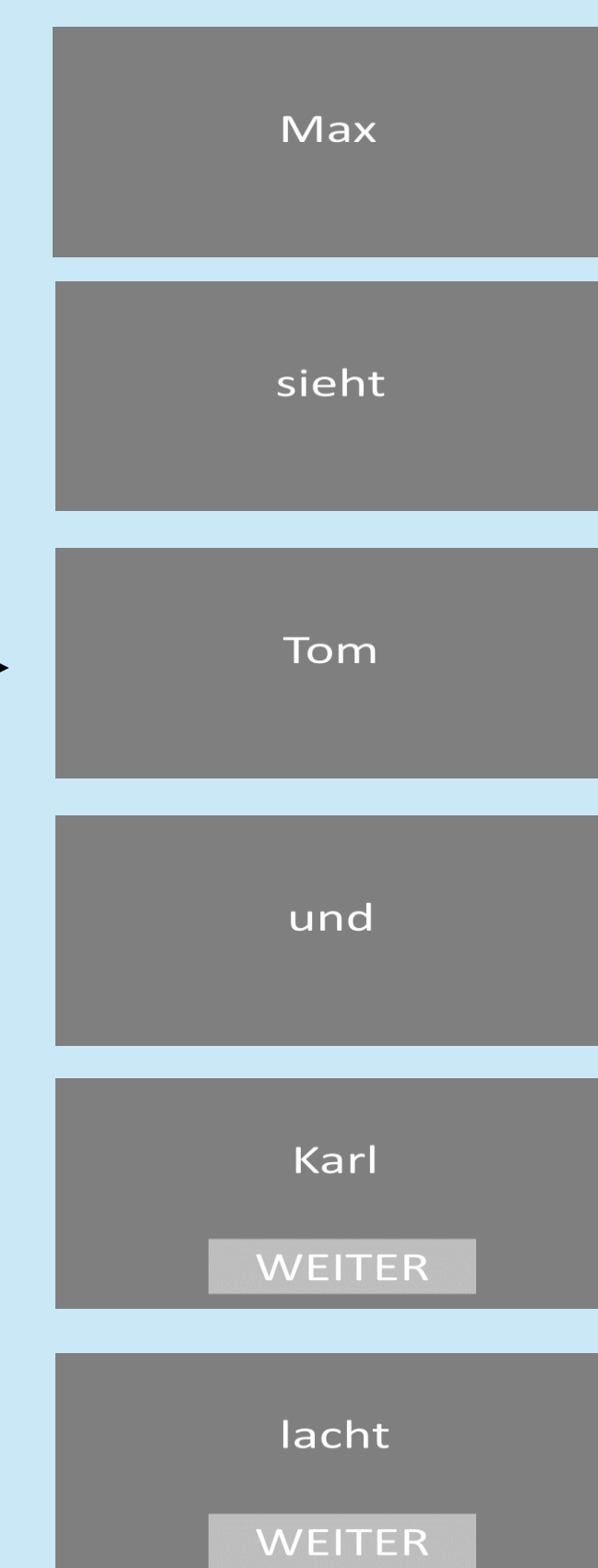
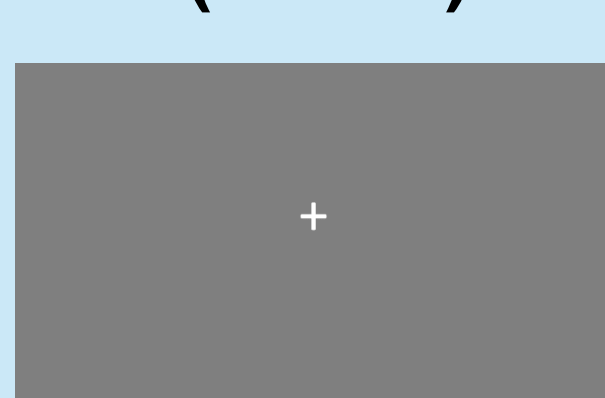
2 clauses Max sees Tom and Karl laughs.
1 clause Max sees Tom and Karl.

- Prosodic contour **repeated 3 times** to induce entrainment, followed by time-matched **RSVP** presentation of the sentence.
- Short contour** (fast entrainment) induces correct chunking of 2-clause sentence, but incorrect in case of 1 clause.
- Long contour**, on the contrary, induces correct chunking of 1-clause sentence, but incorrect in case of 2 clauses.

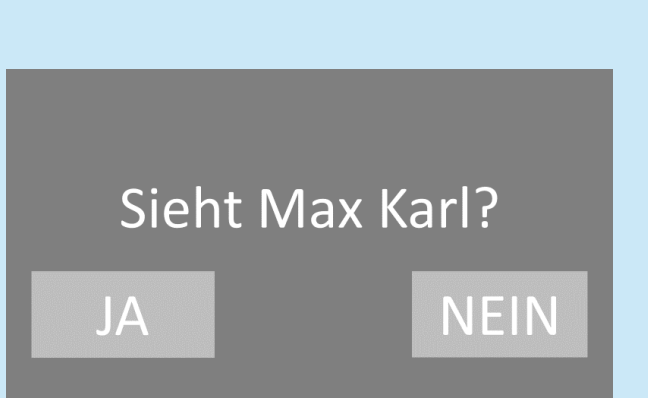
Procedure

Automatic presentation (RSVP)

Audio contour
(carrier)



Comprehension
task



3rd noun (N3)



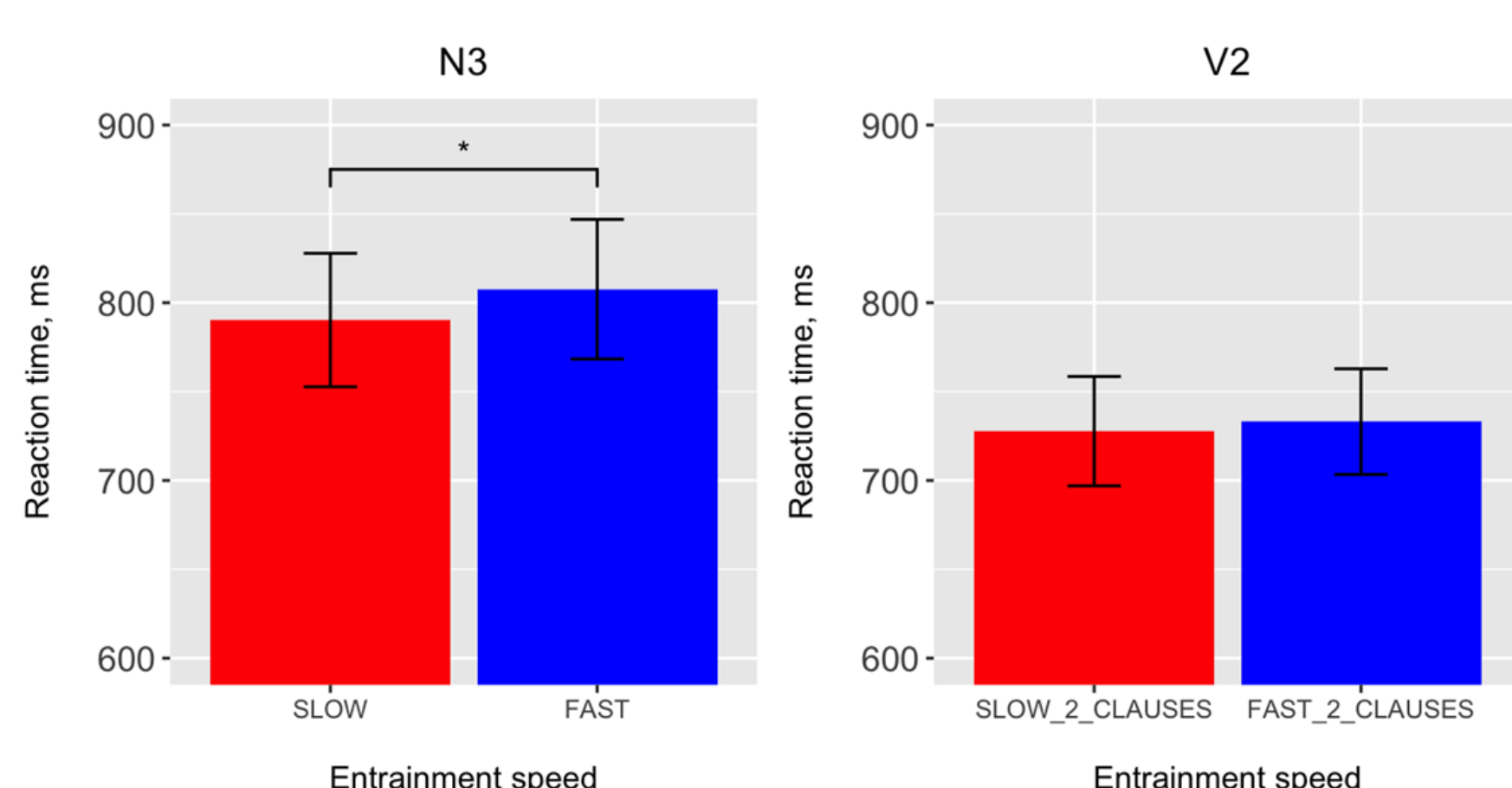
2nd verb (V2)



Results

1

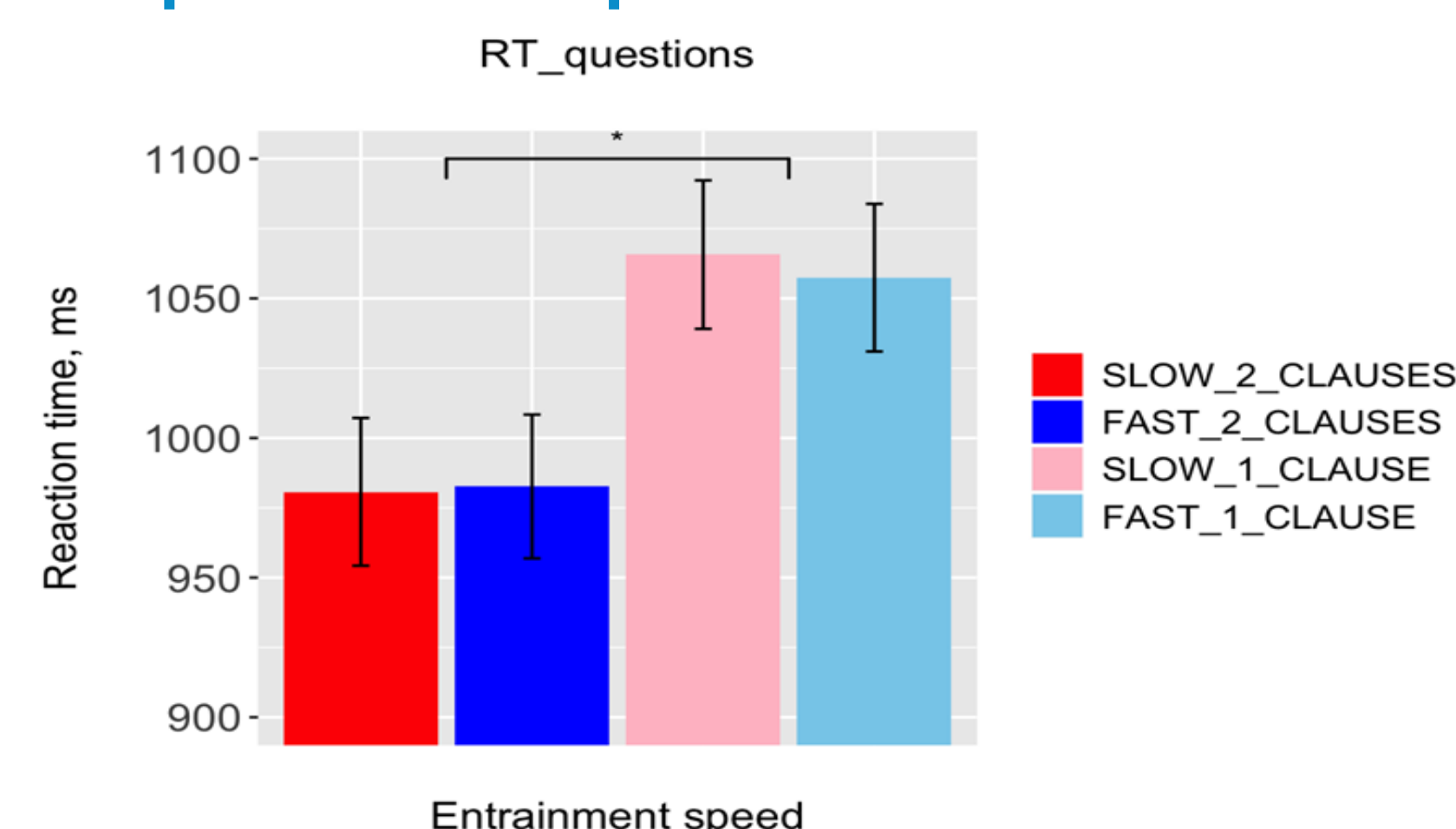
Self-paced reading



- N3: shorter RT in SLOW condition
- V2: no differences for entrainment speed

2

Comprehension questions



- Analysis of correct trials only
- Main effect of sentence type** – 1-clause sentences harder to process;
- Interaction of Sentence type × Entrainment:**
2-clause sentences harder under FAST entrainment;
1-clause sentences harder under SLOW entrainment (against hypothesis).

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:

- Participants always expect a **2-clause (longer)** sentence
- Long sentence expectation strengthened by SLOW entrainment /weakened by FAST:**

- Shorter RT at N3 – expecting continuation
- Shorter RT in question task for 2-clause sentences (opposite effect for FAST)
- Longer RT in question task for 1-clause sentences (opposite effect for FAST)

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.