

Introduction

1. Prosodic boundary (PB) is a type of prosodic information considered to benefit syntactic parsing and lexical access, as it overtly marks constituents segmentation.
2. Topic-Comment constructions are syntactically marked by linear Word-Order position (i.e. sentence-initial) and are usually followed by a PB. These constructions are well known to have sentence/discourse interface proprieties. In Chinese, the so-called "Chinese-style" gapless Topics are separated from the rest of the sentence (i.e., the Comment clause) by means of a special intonational contour and a clearly audible pause, which can be reinforced by particles acting as Topic markers (*y-a*, *ne*, *me* (Li 2006, Badan & Del Gobbo 2010). Critically, the PB in the Topic-Comment construction marks a sentence-level syntactic structure, and is not related to a parsing disambiguation: such a Word-Order can only have one possible interpretation.
3. Closure Positive Shift (CPS) has been found to follow PB (Steinhauer, Alter & Friederici, 1999), yet its relation to PB processing per se is disputable. Some recent studies reported the absence of the CPS for some type of PB (Holzgreffe et al., 2013).

Design & Materials

Research Questions:

1. Neural basis of processing PB in Chinese Topic-Comment construction;
2. How the prosodic boundary modulates the use of contextual information during speech comprehension, addressing a broader question on the online sentence-discourse interface.

Procedure:

Subjects first attentively read a short narrative (context). Then they listened to several critical sentences and judged each one whether it was consistent with the read story, while EEG was recorded. After EEG experiment, they rated the naturalness of the critical sentences they heard.

Design & Materials:

3 (PB/No PB/He violation) x 2 (Rich Context/Plain Context) design.

All critical sentences (see Example) began with a NP/DP that depicted the event location (Topic), followed by another NP (Subject) and a predicate (Verb). *Critically, the verb in critical sentences DID NOT appear in the story (i.e. synonym), but can be deduced from the content.*

Example Sentence:

ERP regions	Topic NP	PB Manipulation	Subject NP	Adv.	Verb	Complement
Critical sentence	江边的酒家	PB NoPB 和 He	赵虎	高兴地	接受	红袖的邀请。
Lit. translation	tavern by the river		Zhao Hu	gladly	accept	RL's invitation
Translation	In a tavern by the river, Zhao Hu gladly accepted the escort girl's invitation.					

PB Manipulation Three versions of each critical sentence were recorded by a native speaker: one with a PB between the Topic NP and the Subject NP of the Comment clause (**PB Condition**), one without a PB (**NoPB Condition**, see Fig. 1), and one with a conjunction (和 *he2*, 'and') to elicit a morphosyntactic violation (**He Condition**).

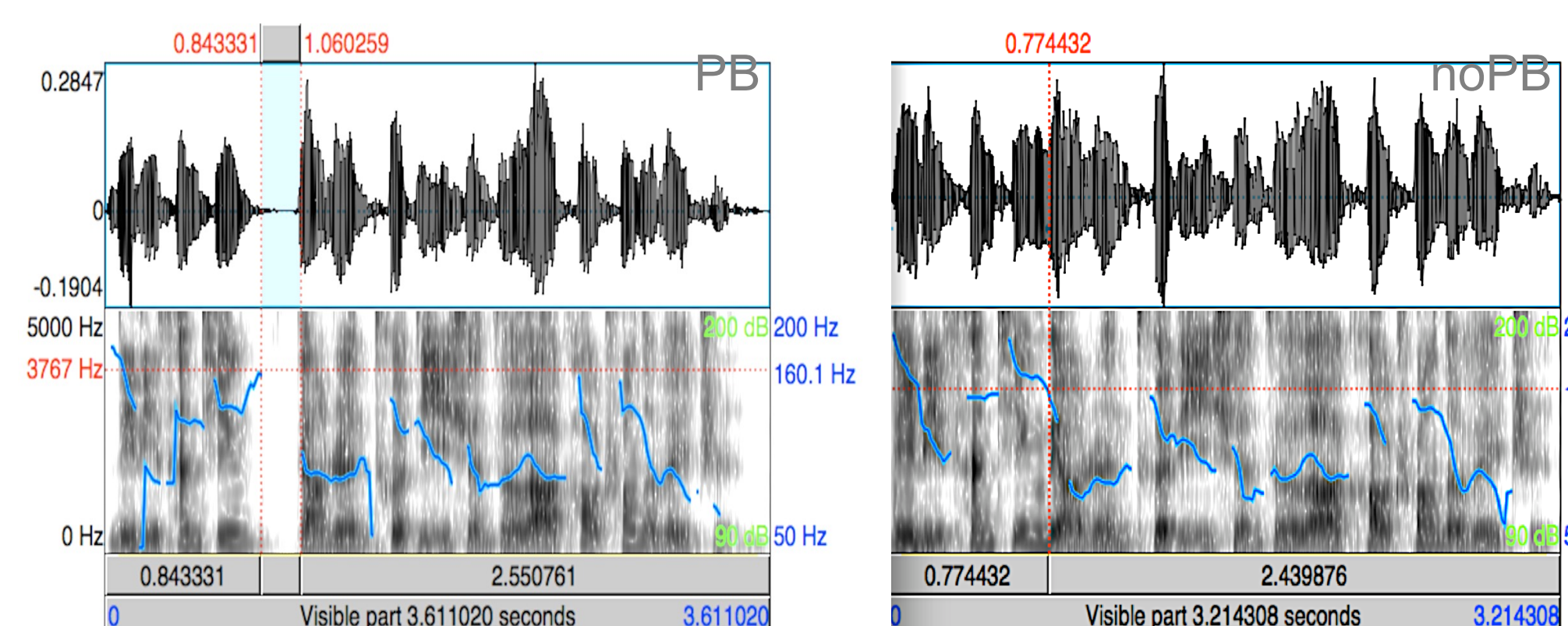


Fig. 1 Spectrogram of two versions of critical sentence 0807y (Left: with PB; Right: without PB). Shaded area illustrating silence. PB-Condition prosodic contour characteristics: (1) Average Pause length 130 ms; (2) Significant Topic DP last syllable lengthening (~100 ms); (3) 20 Hz of average pitch difference (F0) between Topic and Comment.

Context Manipulation Two versions of 21 short narratives were constructed (~320 words): One containing more information about the topic NP of critical sentences (**Rich Condition**); the other of the same length but containing less information about the topic NP (**Plain Condition**).

Results

Behavioral Results

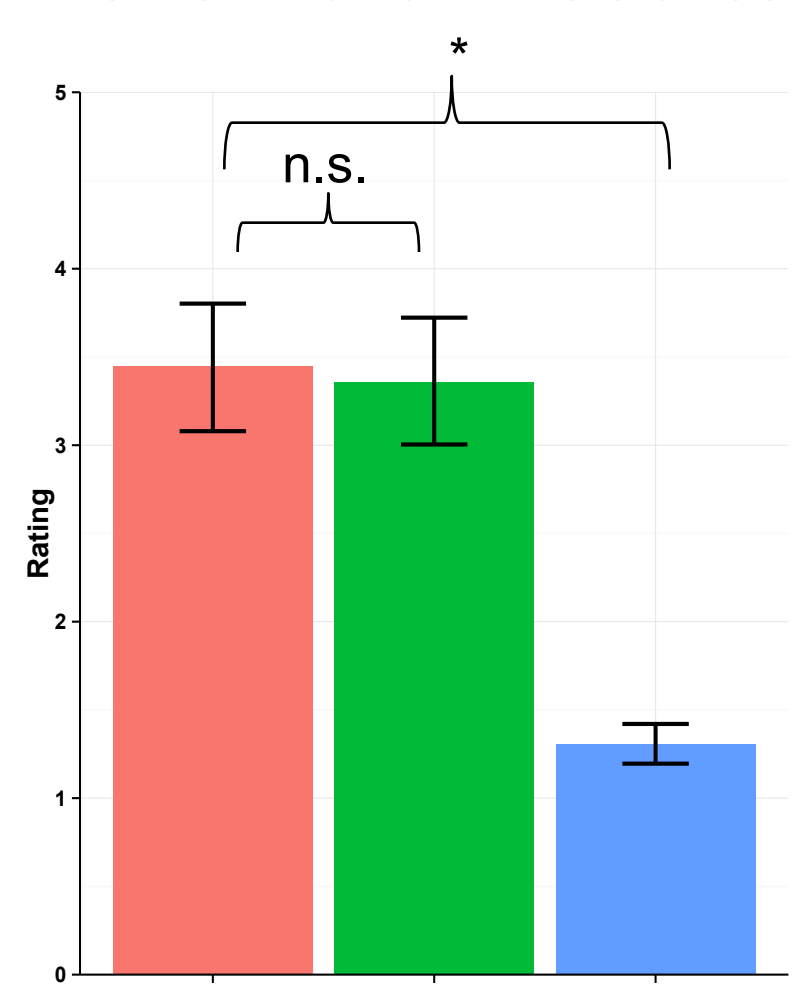


Fig. 2 Results from naturalness judgment (1: Very unnatural; 5: Very Natural) for critical sentences. Sentences w/o PB were both judged to sound more natural than sentences containing a conjunction violation (He condition).

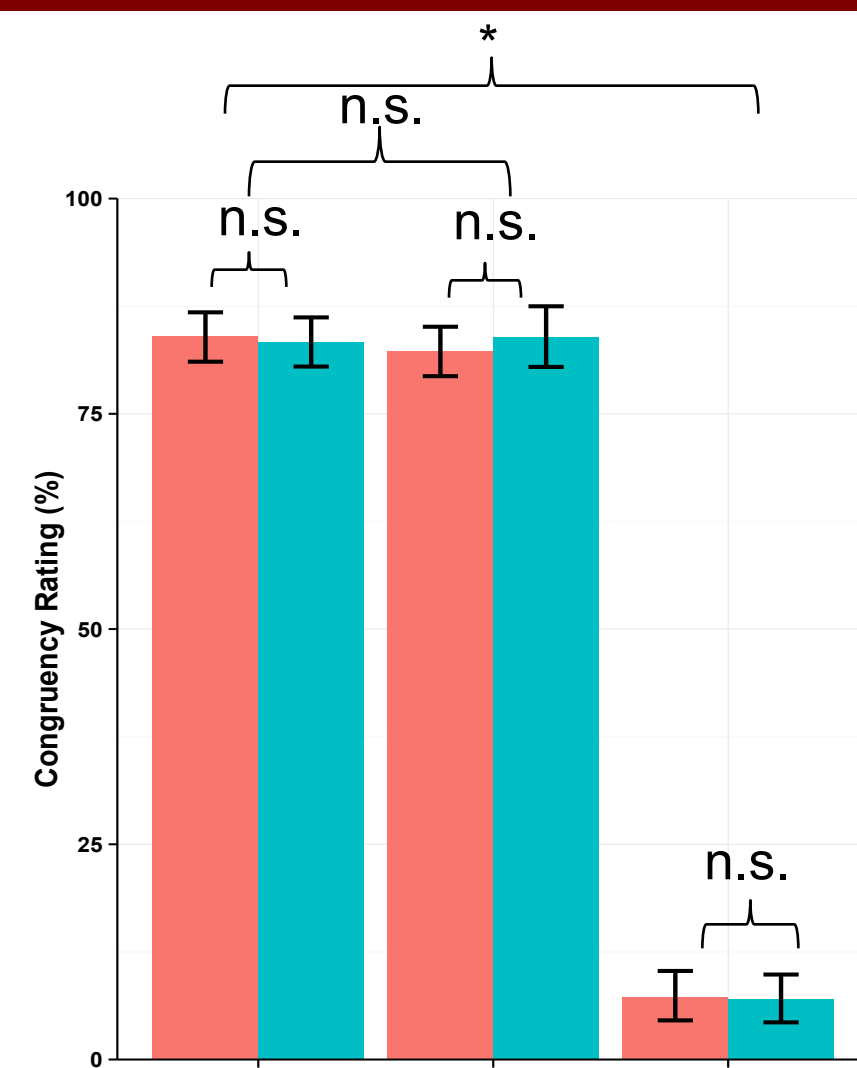


Fig. 3 Percentage of critical sentences judged as consistent in PB condition was not different sentence without PB, but higher than the conjunction violation condition. No main effect of context was found.

Summary: We found no difference between PB and NoPB condition for offline measures. Subjects judged sentences with or without PB to be comparably natural, and they were not more likely to correctly judge the critical sentences as consistent with the story in PB than in NoPB condition.

ERP Results

Analysis Method: Linear mixed-effects models were adopted to analyze average amplitude in each time window (Topic NP, Subject NP and Verb). The t-values for all reported effects are larger than 2 unless specified.

Contrasts in model:

- **PB Effect** (PB vs. NoPB condition)
- **He conjunction Effect** (PB vs. He condition)
- **Context Effect** (Rich vs. Plain context condition)
- **Electrode position** (Left vs. Right; Frontal, Central vs. Posterior)
- **Interactions** among these conditions

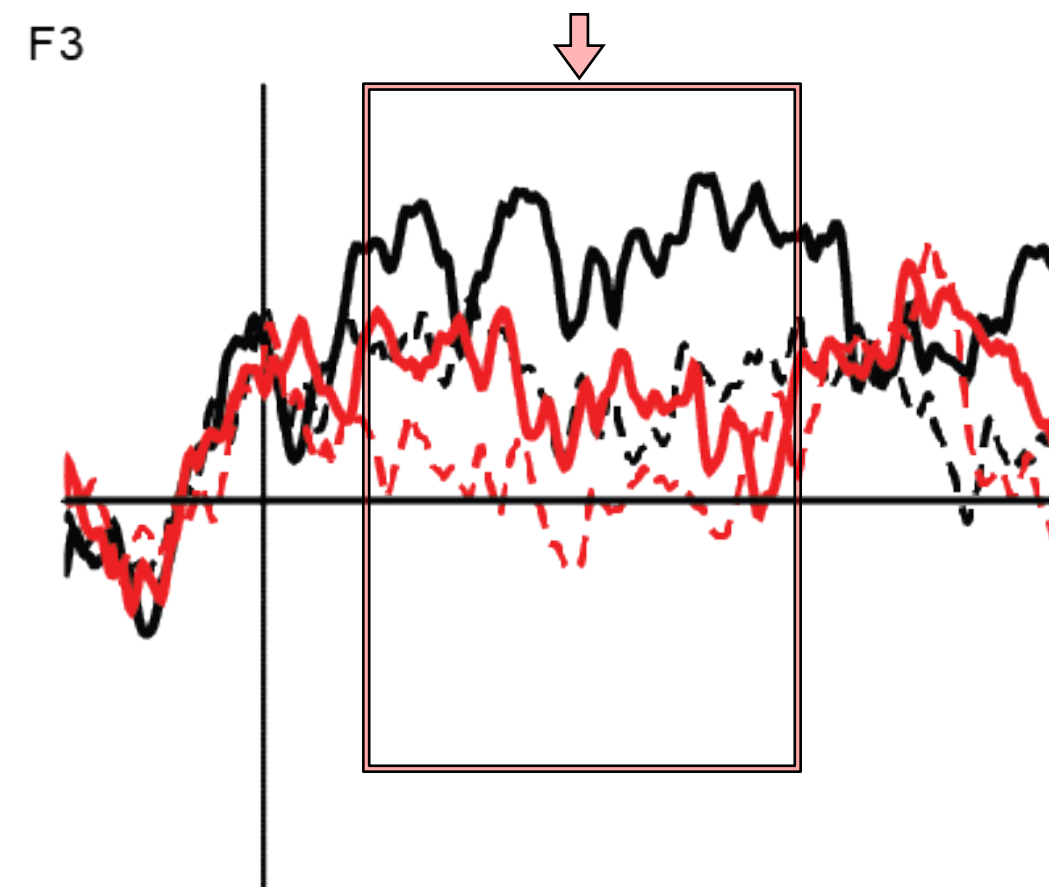
Topic NP: time-locked to the last syllable of Topic NP.

Context effect:

100-500ms: RICH context more positive.

PB effect:

100-500ms: PB more negative, not CPS.

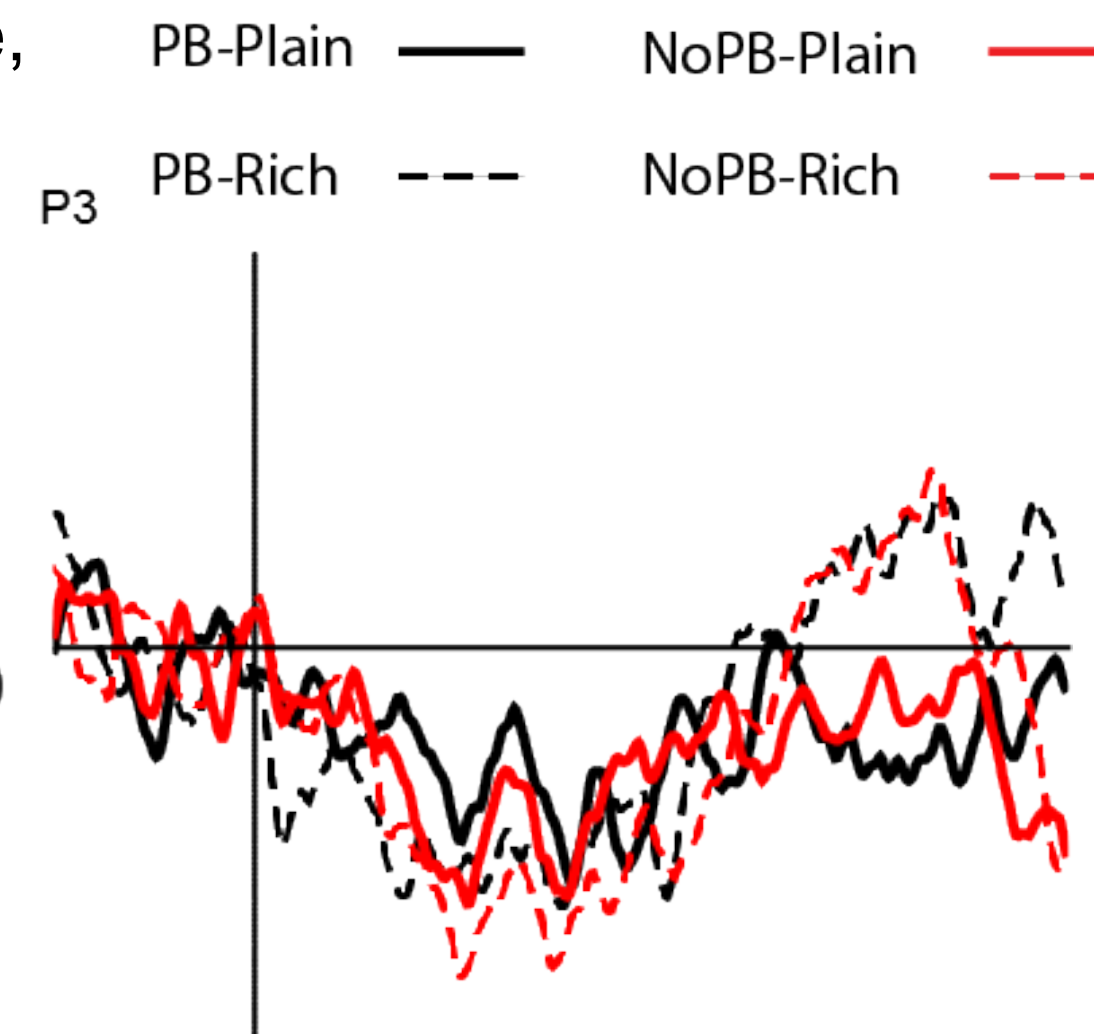
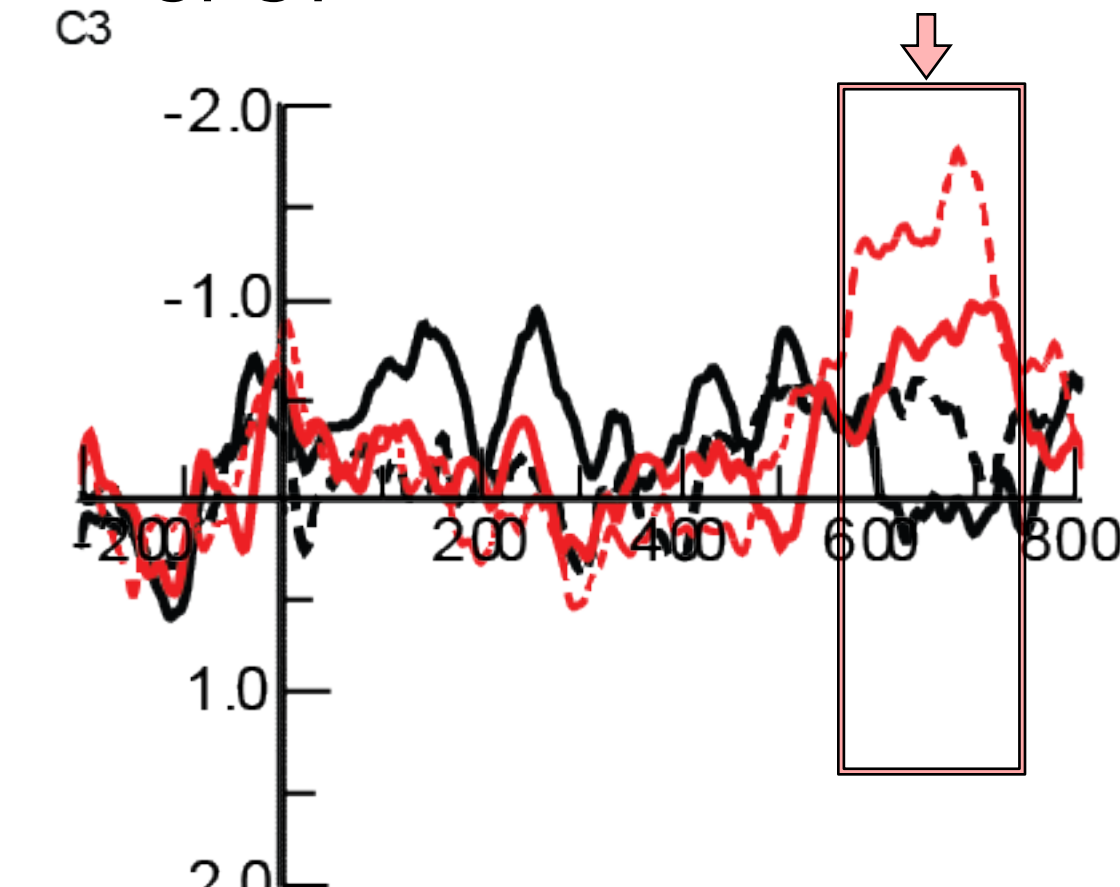


Context effect:

550-700ms: RICH context more negative.

PB effect:

550-700ms: PB more positive, CPS?



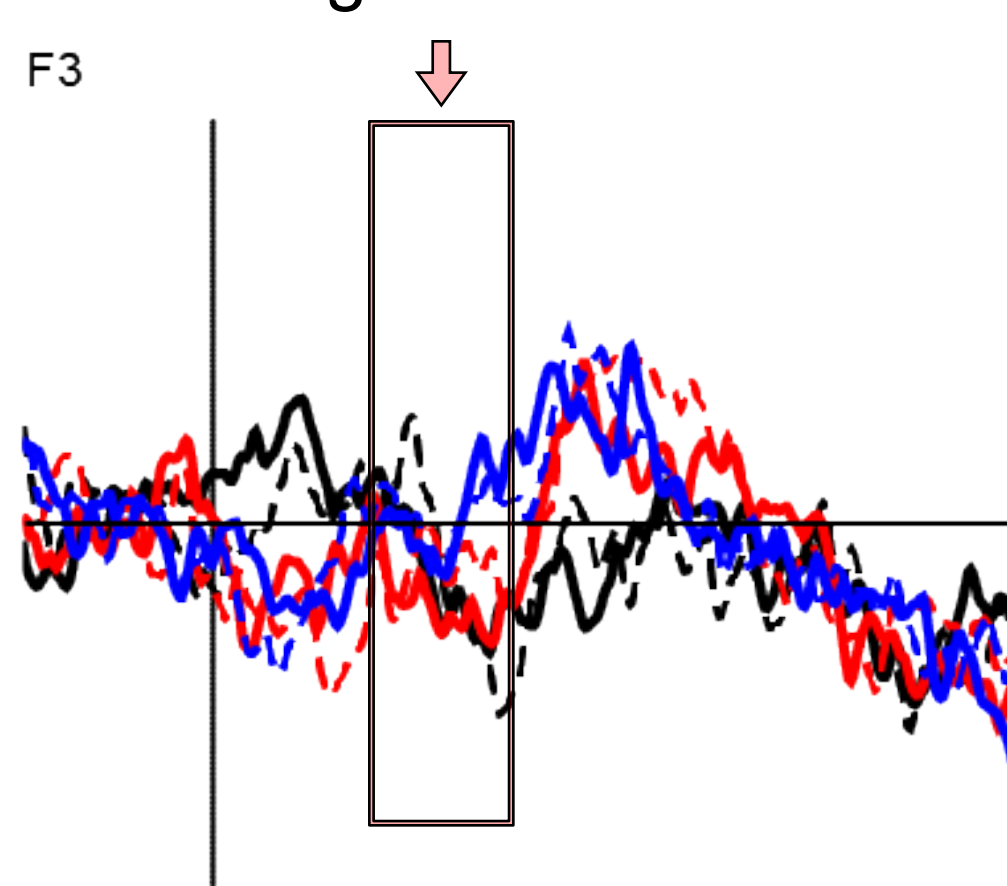
Subject NP: time-locked to the onset of Subject NP.

He effect:

150-300ms: "He" more negative.

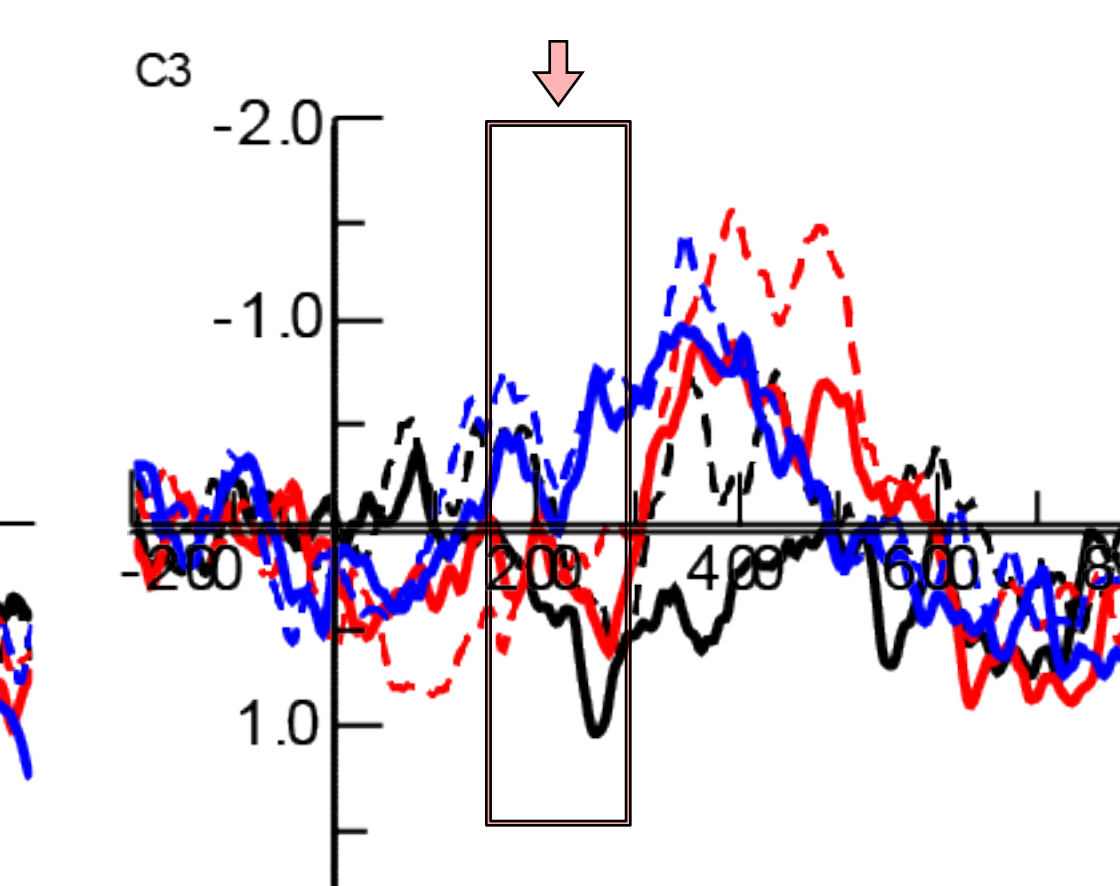
Context effect:

150-300ms: RICH more negative.



PB * Context:

150-300ms: RICH more negative for PB but not for NoPB sentences.

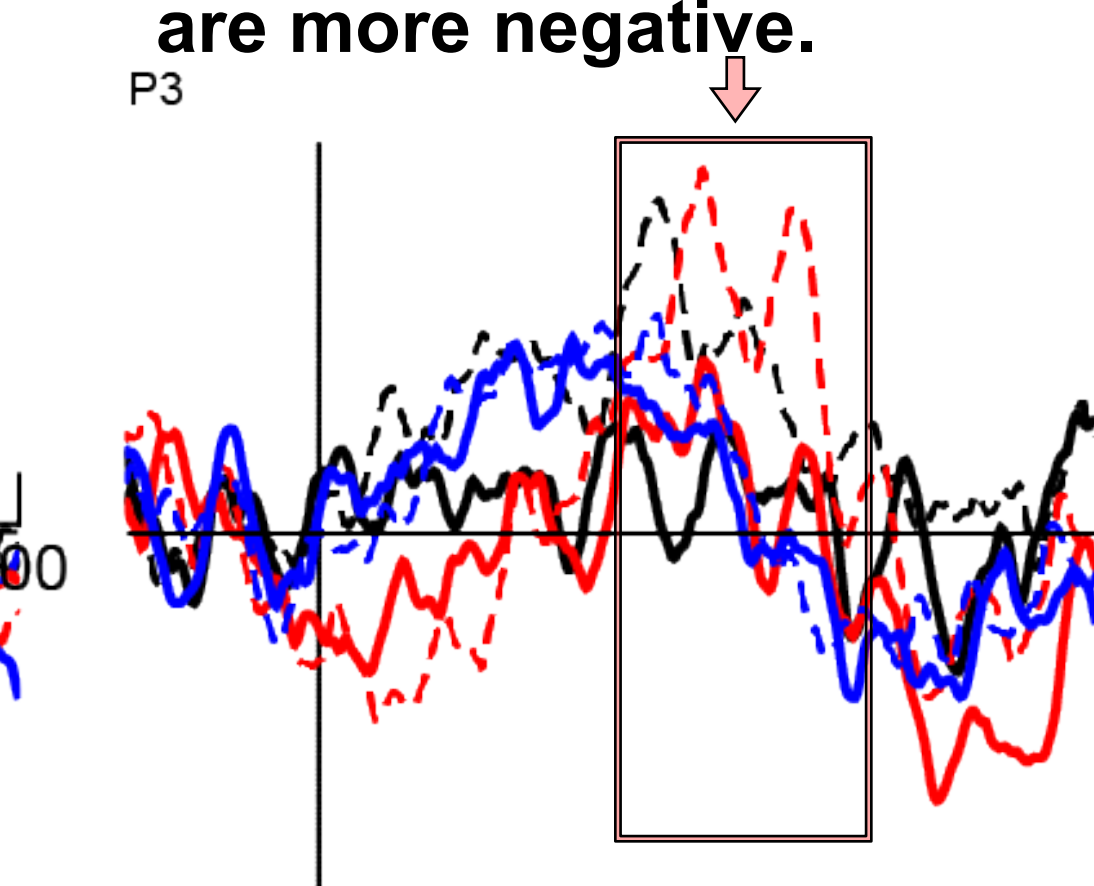


He * Context:

300-650ms (marginal): RICH more negative for PB but not for "He" sentences (t=1.91).

Context effect:

300-650ms: **Rich conditions are more negative.**



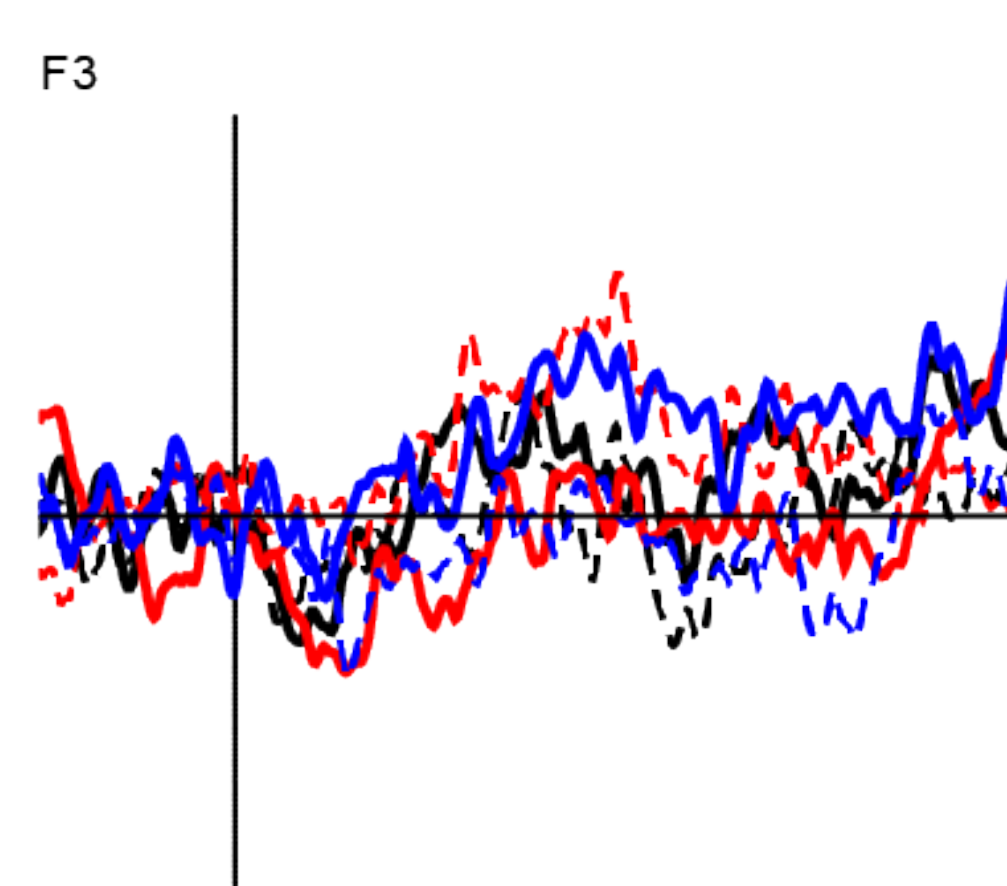
Verb: time-locked to the onset of Verb

PB * Context:

100-400ms: RICH more negative for NoPB but not for PB sentences.

He effect:

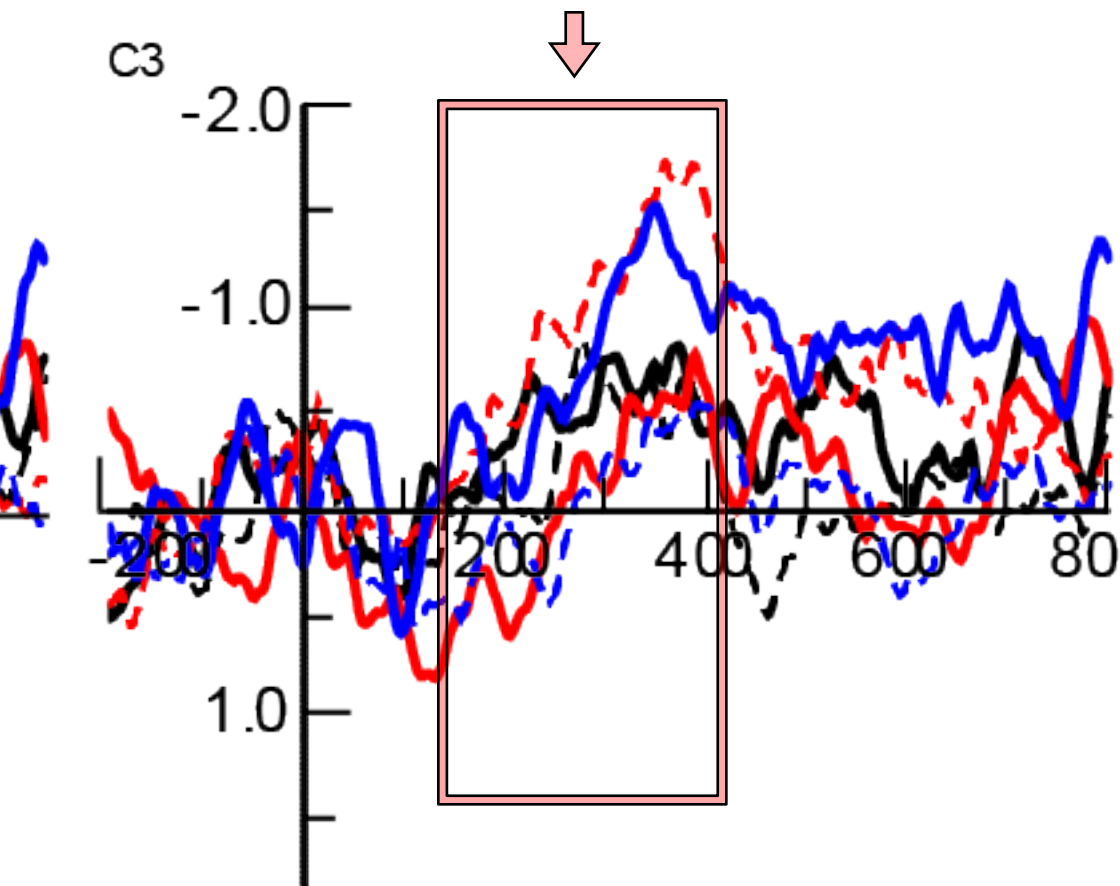
100-400ms: "He" more positive.



100-400ms: RICH more negative for NoPB but not for PB sentences.

He effect:

100-400ms: "He" more positive.

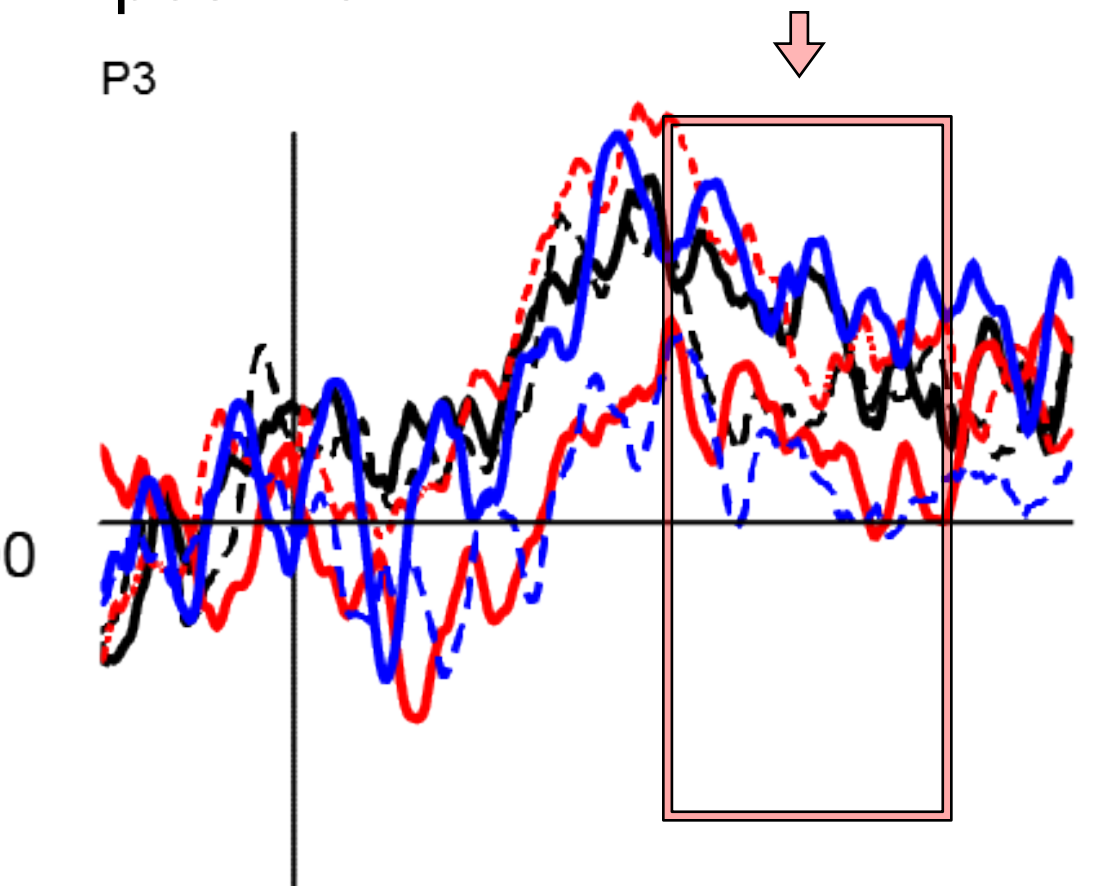


PB * Context:

400-700ms: Rich cond more negative for NoPB but not for PB sentences.

NoPB effect:

400-700ms: NoPB cond more positive.



Legend: PB-Plain (solid black), NoPB-Plain (solid red), He-Plain (solid blue), PB-Rich (dashed black), NoPB-Rich (dashed red), He-Rich (dashed blue).

Discussion

1. A negativity rather than a CPS was found for the PB detection, suggesting that the neural activities may vary responding to different types of PB. However, we did see that PB condition elicit a larger positivity in a later time window, and the negativity we found might correspond to a pre-CPS negativity sometimes reported (Kerkhofs, et al., 2008). The amplitude and latency of the negativity in our study, however, was not exactly comparable.
2. "He" effect preceded PB effect both at Subject NP and Verb, indicating that lack of PB after Chinese-style Topic was not processed as a morpho-syntactic violation.
3. Rich Topic-related contextual information elicited larger sustained negativity on Subject NP and Verb, possibly reflecting larger memory load.
4. Critically, we see a modulation effect of PB on Context effect. While Context effect on Subject NP occurred only for PB sentences, later on the Verb, contextual load did not show difference for PB sentences when it did show an effect for NoPB sentences. This results suggested that the presence of prosodic cues facilitated the use of contextual information. In NoPB condition the syntactic structure is discovered later, resulting in the observed later sensitivity to contextual load.

References

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- Kerkhofs, R., Vonk, W., Schriefers, H., & Chwilla, D. J. (2008). Sentence processing in the visual and auditory modality: do comma and prosodic break have parallel functions? *Brain Research*, 1224, 102-118.
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