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### investigating the pre-activation negativity

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# Anticipating morphological and syntactic structures

## An analysis of the pre-activation negativity (PrAN)

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### Introduction

- Listeners constantly try to predict upcoming words when processing speech
- A brain potential – the ‘pre-activation negativity’ (PrAN) – has been suggested to reflect morphological pre-activation of likely word endings [1-4]
- We tested whether PrAN could be found in syntactically predictive contexts as well

### The present study

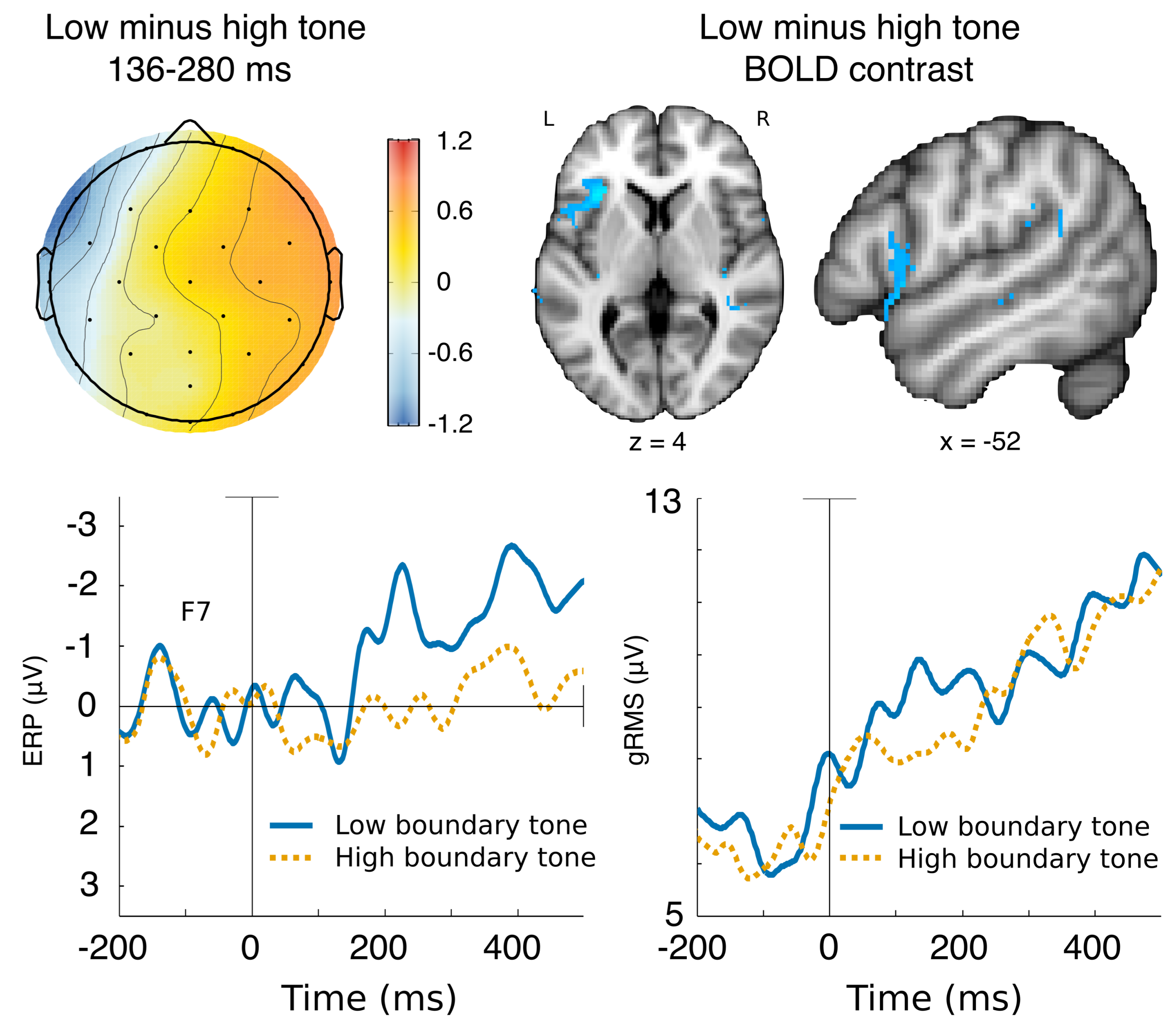
- Using a concurrent fMRI/ERP paradigm, we tested whether syntactic structure could be pre-activated based on strongly constraining tonal cues
- In Swedish, clause-initial tones (low/high) function as cues to syntactic structure
- Low tones are more predictively constraining (cueing only one type of structure), whereas high tones are less constraining (cueing a larger class of structures)
- More predictively useful tones gave rise to **left frontal ERP negativity (PrAN)** 140 ms after tone onset, as well as activity in **left insula and inferior frontal gyrus**
- Invalidly cued word orders elicited **P600** after low – but not high – tones, suggesting the disconfirmation of a syntactic prediction

PrAN  
bå-... -ten/-tar/-t-hus...  
boat-...-the/-s/-house

PrAN  
Jim hävdar att Caesar<sub>Low tone</sub> inte intog Gallien 'Jim claims that Caesar not conquered Gaul'  
Jim hävdar att Caesar<sub>High tone</sub> intog inte Gallien 'Jim claims that Caesar conquered not Gaul'

### Method and results

- 19 native speakers of Swedish (11 female, mean age 24.5 years)
- Concurrent event-related fMRI/ERP (Brain Products GmbH)
- 50% of sentences had invalid word orders based on tonal cue (LoInvalid/HiInvalid)
- ERP data from 16 participants analysed
- Two time points: predictive tone onset, and word order disambiguation point
- Low tones gave rise to ERP negativity in 136-280 ms time window (cf. [3]) over left-lateralised electrodes ( $F(1,15) = 7.252, p = 0.017$ )
- A gRMS analysis revealed two peaks of neural activity at 100-150 ms ( $F(1,15) = 5.691, p = 0.031$ ) and 150-230 ms ( $F(1,15) = 5.264, p = 0.037$ ) for low tones
- P600 over left electrodes for LoInvalid ( $F(1,15) = 5.354, p = 0.035$ )
- Slower response times for LoInvalid as well ( $F(1,15) = 5.944, p = 0.028$ )
- A conjunction analysis (to isolate effects of tone) was performed on fMRI data ( $z$  threshold = 3.2,  $p = 0.001$ , GRF statistics)
- Largest cluster for the low minus high tone contrast spanned the left anterior insula and left inferior frontal gyrus
- Subject variability correlation between BOLD in prefrontal cluster and gRMS ( $r = 0.609, p = 0.024$ )



### Conclusions

- Strong cues to syntactic structure elicited ERP negativity (PrAN) as early as 140 ms after cue onset
- Disconfirmed predictions gave rise to P600
- PrAN was found to mainly be underpinned by activity in left insula and IFG (cf. [6-9])
- Syntactic structures can be pre-activated based on a strongly constraining cue

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