Two late positivities during language comprehension:
The influence of wrap-up and cognitive control

Trevor Brothers, Eddie Wlotko, Simone Riley, Margarita Zeitlin, Connie Choi, Gina Kuperberg

[1] Athinoula A. Martinos Center for Biomedical Imaging, Massachusetts General Hospital; [2]Tufts University, [3] Moss Rehabilitation Center

Introduction

During sentence comprehension, context can influence both the initial access of word meanings (300-500ms) and more prolonged, re-interpretive processes (500-1200ms). Here, we investigated the cognitive mechanisms underlying two late post-N400 positivities, which are known to vary as a function of predictability and plausibility.

- **Late Frontal Positivity (PNP)** - Triggered by plausible but unexpected words, reflecting late interpretive processes
- **Late Posterior Positivity (P600)** - Triggered by semantically or syntactically anomalous continuations that violate predicted event structures

We recorded event-related potentials (ERPs) during sentence comprehension (visual RSVP) to determine how wrap-up and cognitive control might impact these two post-N400 ERP components.

Methods

Participants read 168 sentences which varied in contextual constraint, and they provided plausibility judgments after a delay. Critical nouns were either **Expected** (85% cloze), **Unexpected** yet plausible (1%), or **Anomalous** in context.

Experiment 1: N = 37, critical words appeared in *sentence-medial* position followed by a few additional words
Experiment 2: N = 33, the same CWs appeared in *sentence-final* position with a period to elicit sentence wrap-up

In the same session, all participants completed a 400-trial "AX" Continuous Performance task. We assessed accuracy (AX/AY, d') and reaction time variability to determine whether cognitive control ability predicts individual variability in neural responses to unexpected or anomalous language input.

References

1) *Multiple effects of sentential constraint on word processing. Federmeier, Wlotko, Ochoa-Dewald & Kutas, 2007*
2) *The role of domain-general cognitive control in language comprehension. Fedorenko, 2014*
3) *Dissociating working memory from task difficulty in human prefrontal cortex. Barch et al., 1997*

Effect of Sentence Wrap-up
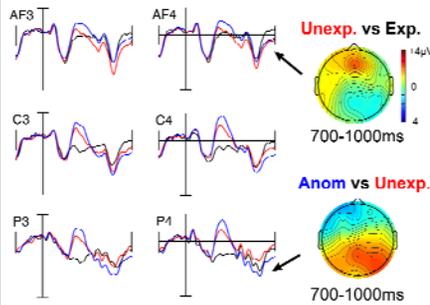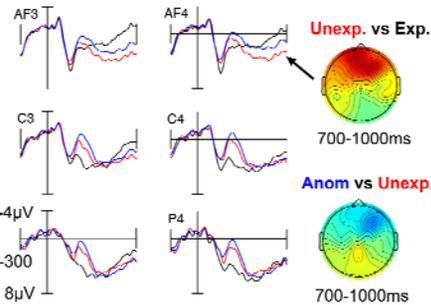
Father carved the turkey with a **knife** / smile / beach...

He grew corn to feed his children / igloos...

Effect of Cognitive Control
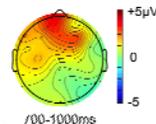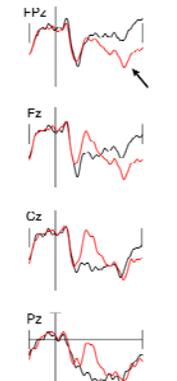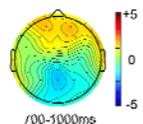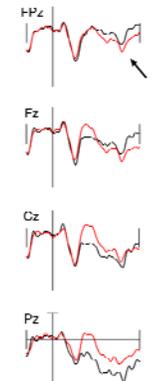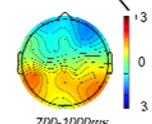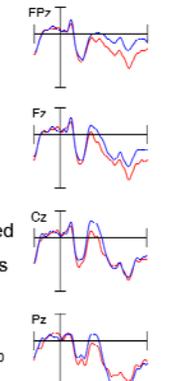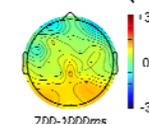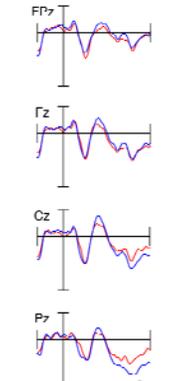
*Combined Exp.1 and Exp.2 data. Plots represent top and bottom tertile of cog. control ability (N=24)*

ERP Results

- Cloze probability and semantic anomaly both influenced the size of the N400, with no differences for sentence-medial and sentence-final words.
- Unexpected, plausible words triggered a *late frontal positivity* that was enhanced at sentence-final positions (1.2μV vs. 3.0μV, *p* = 0.01).
- Anomalous words triggered a *posterior positivity* (P600) that was slightly smaller in sentence-final positions (1.6μV vs. 0.7μV, n.s.*)
- Both AX-CPT accuracy and RT-variability were significantly correlated (*r* = 0.72), so we combined them into a single cognitive control index.
- Readers with better cognitive control showed larger frontal positivities (*r* = 0.34, *p* = 0.003), but control abilities did not correlate with either N400 or P600 effects.

Discussion

- Initial semantic access was not influenced by sentence wrap-up (N400), but we did observe wrap-up effects during later processing stages.
- Discourse re-interpretation mechanisms, indexed by the frontal PNP, appear to be enhanced when encountering a clause boundary.
- Individual differences in cognitive control uniquely predicted the amplitude of the late frontal positivity, suggesting that shifting discourse models or suppressing incorrect predictions during comprehension require domain-general control mechanisms.

AX-CPT Design

Frontal PNP

r = 0.34**

P600

n.s.

N400

n.s.
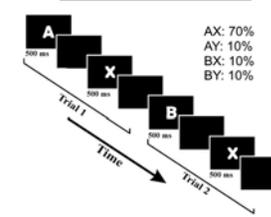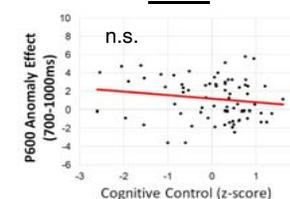
AX-CPT - ERP correlations

n = 70	AX d'	RT_var	f-PNP	N400	P600
AX-CPT d'	-				
RT_var	**0.72**	-			
fPNP	**0.26**	**0.37**	-		
N400	0.14	0.02	-0.18	-	
P600	-0.2	-0.19	-0.23	0.04	-