



When meaning is not informative: Dissociating semantic composition and information accrual in MEG

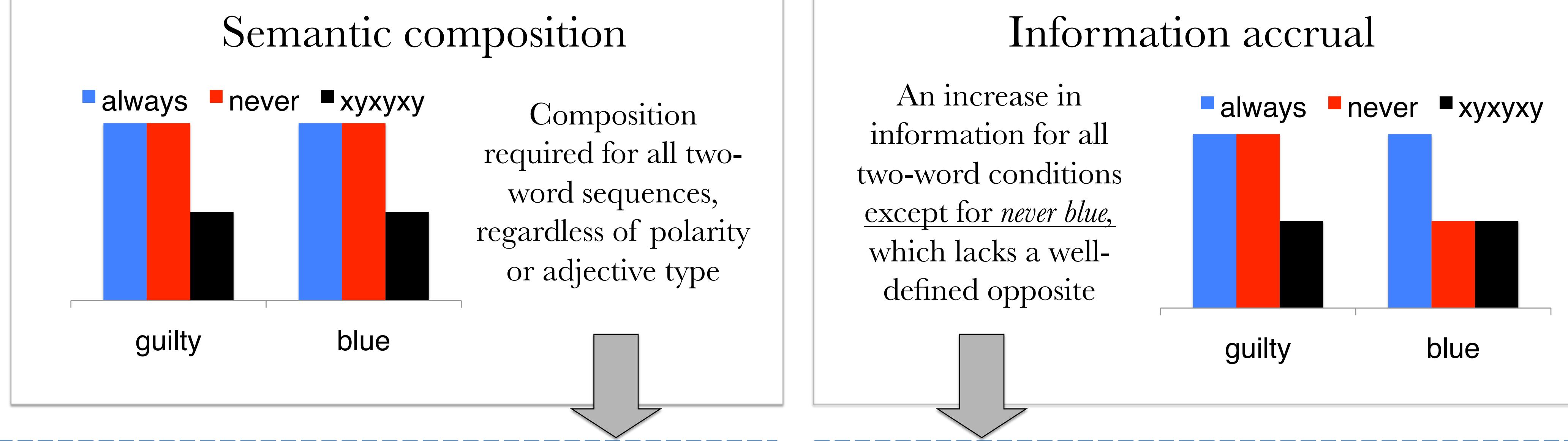
Ellen O'Connor (USC) & Liina Pylkkänen (NYU, NYUAD)



Introduction

- How can we isolate the brain correlates of semantic composition, given the many other tightly correlated processes?
- CAT VS. BLACK CAT: application of predicate modification + increase in conceptual specificity
- Are combinatory effects actually related to information accrual?
- Two particular candidate regions:
 - (Left) ATL: involved in processing sentences [1, 2] as well as specific or subordinate-level meanings [3]
 - VMPFC: associated with semantic operations [2, 4] but also decision-making, reward valuation and theory of mind

Hypothesized ROI activity profiles



Methods

Goal: manipulate information content, keeping composition constant

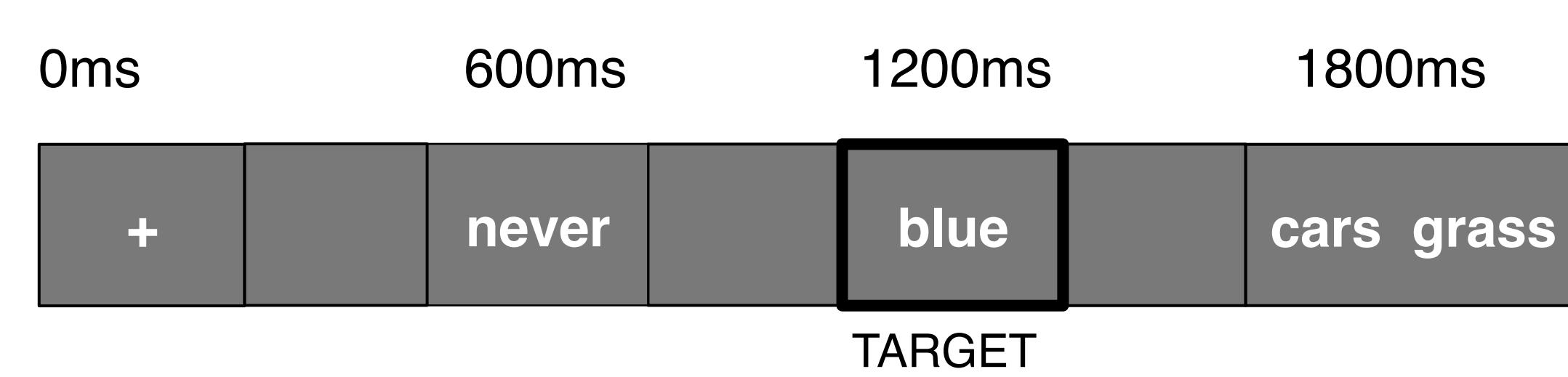
The specificity of a composed negative expression depends on whether a well-defined opposite exists [5, 6]

Design: 2 x 3, CONTEXT (always/never/xyxxyx) and ADJ. TYPE (binary/nonbinary)

"Binary": not guilty → innocent
"Nonbinary": not blue → ??

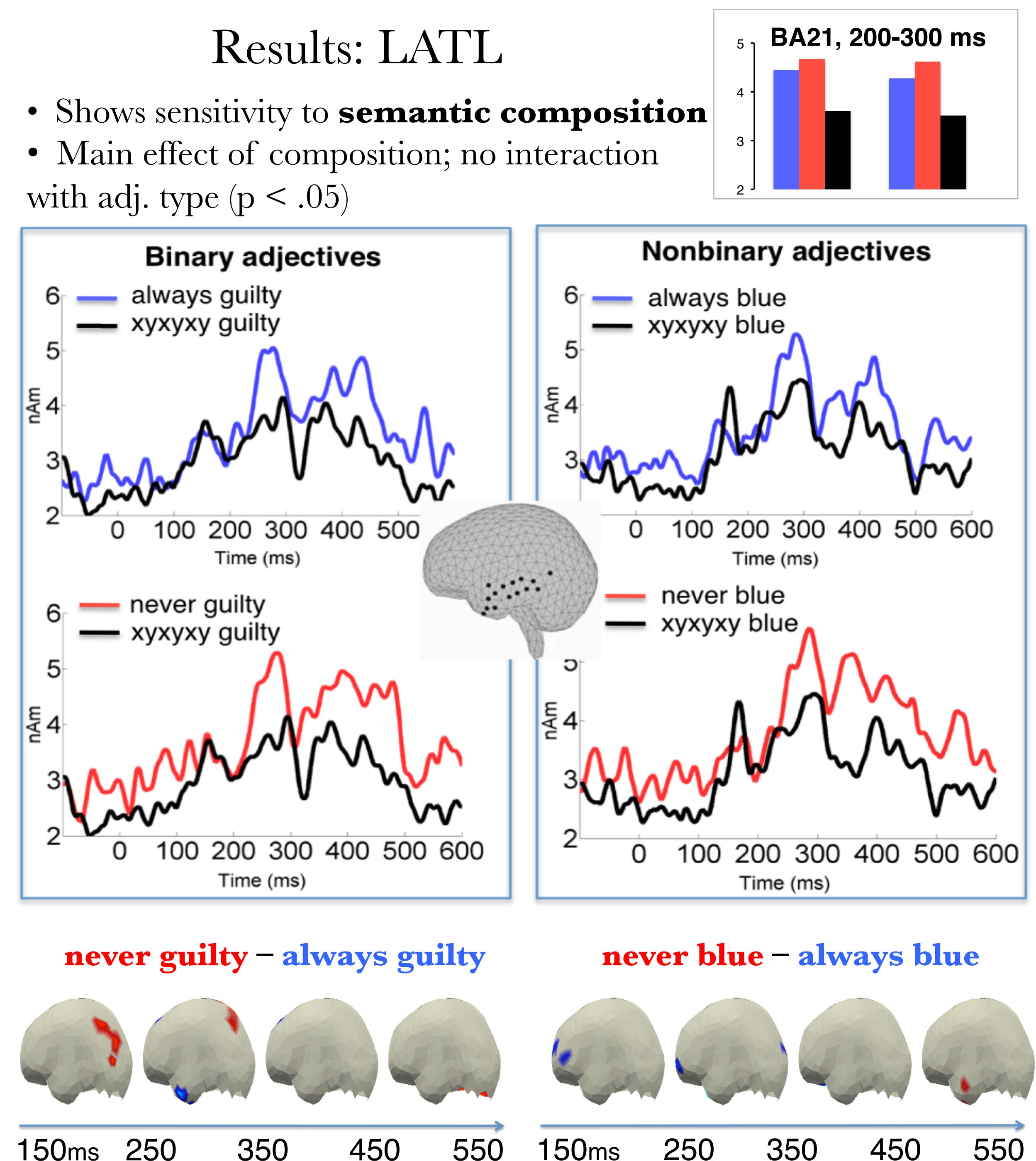
COMPOSITION	BINARY		NON-BINARY	
	never guilty	never blue	always guilty	always blue
BASELINE	xyxxyx guilty	xyxxyx blue		

- Binarity normed on Mechanical Turk (60 adjectives of each type; 360 items total)
- Adjs matched for lexical properties (English Lexicon Project) and bigram frequency (COCA)
- n = 18 native English speakers
- Task: read two-word descriptions; select the noun that fits the description the best:



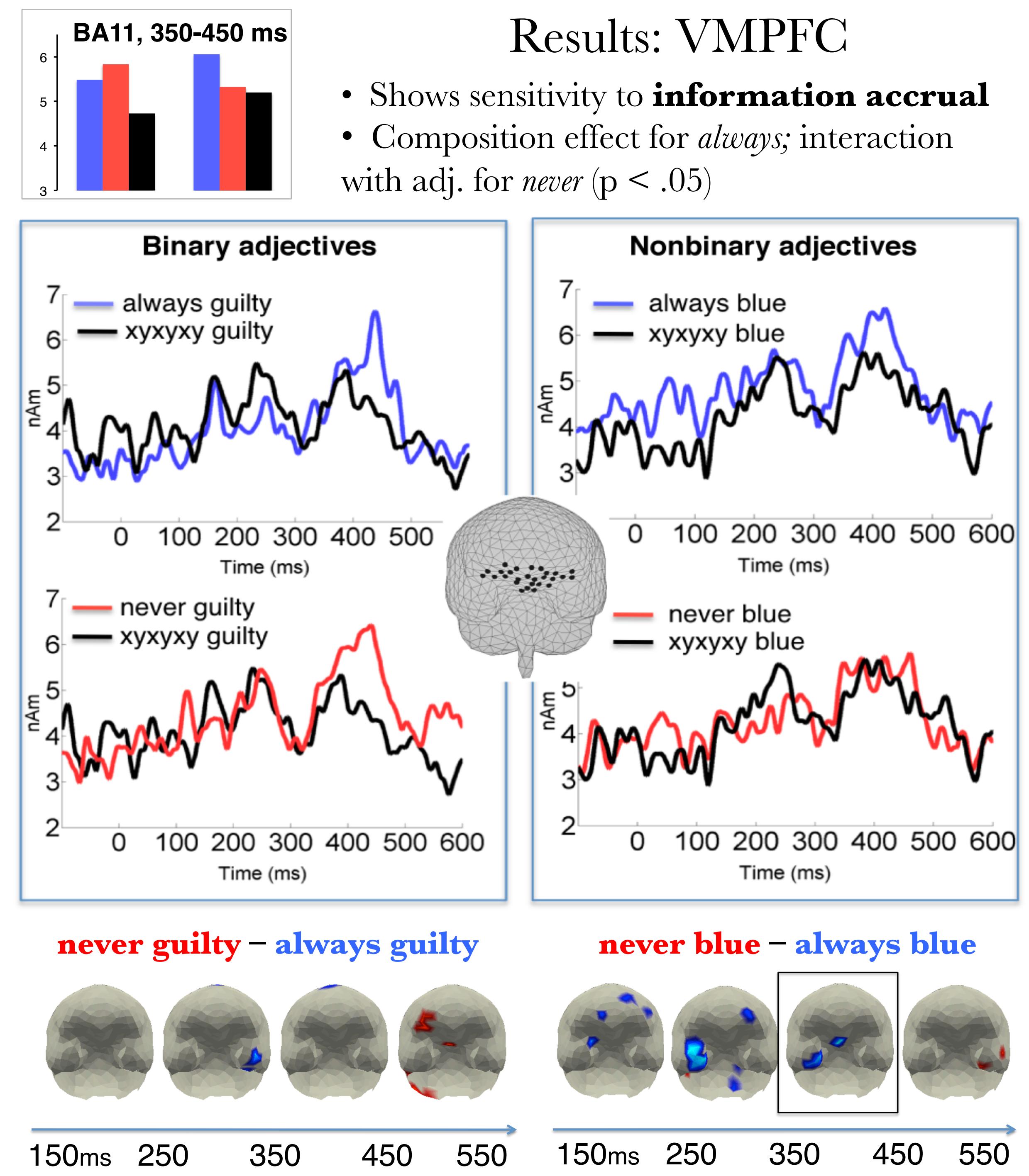
Results: LATL

- Shows sensitivity to **semantic composition**
- Main effect of composition; no interaction with adj. type ($p < .05$)



Results: VMPFC

- Shows sensitivity to **information accrual**
- Composition effect for *always*; interaction with adj. for *never* ($p < .05$)



Behavioral Results

- Main effects detected for CONTEXT and ADJ. TYPE:
- Slower RTs, lower accuracy for *never* ($p < .05$)
- Slower RTs, lower accuracy for binary adjectives ($p < .05$)

Other ROIs

- No clusters in **LAG** (BA 39) or **RATL** (BA 38, 21) survive FDR correction
- Main effect of composition for *never*, marginal composition effect for *always* ($p = .074$) in **LIFG** (BA 44-45):

Conclusions

Composition often yields an increase in specificity; however, these factors are dissociable within the semantic network

LATL: behaves as expected for a locus of semantic composition

VMPFC: sensitive to the informational specificity of expression

This suggests **the VMPFC is not crucially involved in semantic computation, but is sensitive to the output of these operations**

Plausible given that VMPFC damage leaves core linguistic processing intact

VMPFC likely has a (domain-general) role in integrating information from lower systems

References

- [1] Mazoyer et al (1993). The cortical representation of speech. JCN 5, 467-479. [2]
- Bemis & Pylkkänen (2011). Simple composition: an MEG investigation of the comprehension of minimal linguistic phrases. JCN 31, 2801-2814. [3]
- Patterson et al (2007). Where do you know what you know? Nat Rev Neurosci 8(12), 976-987. [4]
- Pylkkänen & McElree (2007). An MEG study of silent meaning. JCN 19, 1905-1921. [5]
- Horn (1989). A Natural History of Negation. [6] Leech (1982). Principles of Pragmatics. [7] Maris & Oostenveld (2007). Nonparametric statistical testing of EEG- and MEG-data. JNM 164, 177-190.