

# Sensitivity to syntax in visual cortex: a manipulation of prediction strength and morphological type

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Surprisingly, violations of word category expectations can affect event-related potentials as early as 120ms, in the same time window as early sensory processing.

In this research, we ask what explains the early latency of these effects.

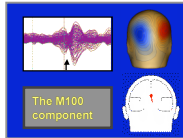
## Introduction / Hypotheses

In two experiments, we tested the following two hypotheses to elucidate the rapid onset of responses to word category violations:

- Rapid word category identification relies on overt category-marking closed-class morphemes
- Violations of word category predictions affect modality-specific sensory responses

## MEG and the visual M100

In both Expt. 1 and Expt. 2, subjects read sentences word-by-word (300ms on, 300ms off) containing a target word that either met or violated structural expectations.



Multi-dipole modeling was performed to capture amplitude modulations as a result of detecting a word category violation. The main focus of analysis was the visual M100 component, the first prominent MEG response to visual stimulation, around 100-150ms.

## Expt. 1 - The role of sensory cortices

### Stimuli

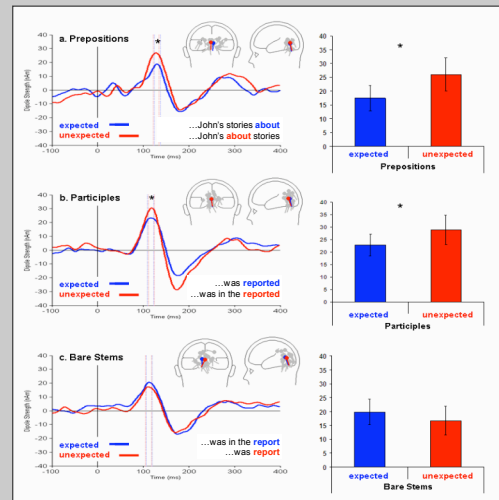
Experiment 1 tested 3 types of target words: Prepositions (closed-class, free morphemes), Participles (containing a closed-class, bound morpheme), and Bare Stems (containing no overt marking of word category).

### Results

Increased M100 amplitudes were found for word category violations involving a preposition or a participle, but not for the bare stem.

### Conclusion

Violations of word category predictions affect a sensory response, the visual M100. This effect may be limited to closed-class morphemes.



## Expt. 2 - The role of closed-class morphology

Possible explanations for the lack of an effect in the bare stem conditions:

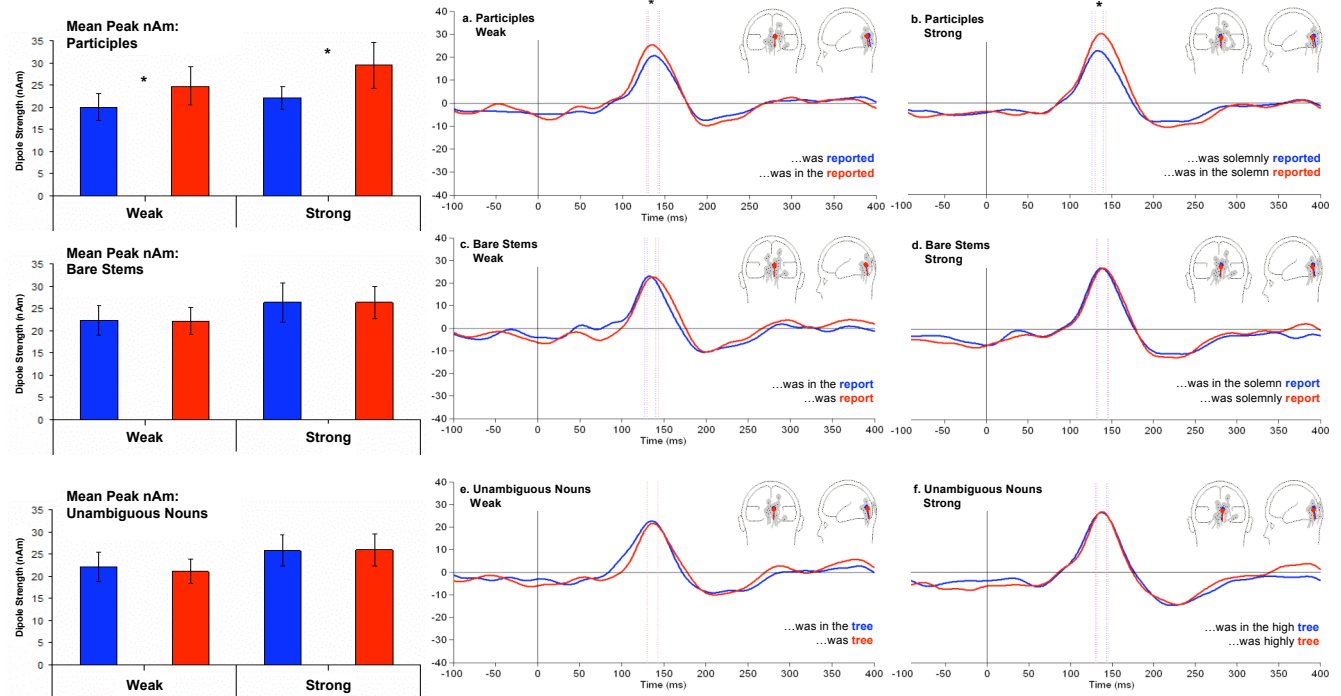
- The target's word category was ambiguous between a noun and a verb
- The target violated a weak, not strong, prediction for an alternative word category
- The target lacked closed-class morphology

### Stimuli

Target items (participles, bare stems, unambiguous nouns) varied in category ambiguity, closed-class morphology, and whether their context strongly or weakly predicted an alternate word category (unexpected items only).

word category	condition category ambiguity	prediction level	expected		unexpected	
			example sentence	cloze-prob.	example sentence	cloze-prob.
Participle	unambiguous	a. weak	The discovery was <b>reported</b> .	0.27	The discovery was in the <b>reported</b> .	Part: 0 Noun: 0.86
		b. strong	The discovery was <b>solemnly reported</b> .	0.79	The discovery was in the <b>solemn reported</b> .	Part: 0 Noun: 0.90
Bare stem	ambiguous	c. weak	The discovery was in the <b>report</b> .	0.86	The discovery was <b>report</b> .	Noun: 0 Part: 0.27
		d. strong	The discovery was in the <b>solemn report</b> .	0.90	The discovery was <b>solemnly report</b> .	Noun: 0 Part: 0.79
Noun	unambiguous	e. weak	The owl was in the <b>tree</b> .	0.79	The owl was <b>tree</b> .	Noun: 0 Part: 0.23
		f. strong	The owl was in the <b>high tree</b> .	0.89	The owl was <b>highly tree</b> .	Noun: 0 Part: 0.59

In all graphs: expected (blue line), unexpected (red line)



## CONCLUSIONS

This research demonstrates that the visual cortex is able to monitor syntactic predictions about upcoming word categories, but only if the category is overtly expressed by a closed-class morpheme. Although the nature of this ability requires further investigation, the finding that sensory cortex participates in syntactic processing in any way is a striking one, and potentially a key element for understanding how language processing can be so remarkably fast.