

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

Hugh Rabagliati / Suzanne Dikker & Liina Pykkänen, Departments of Linguistics and Psychology, New York University

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.

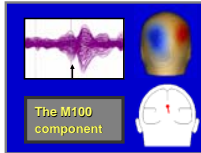
Introduction / Hypotheses

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

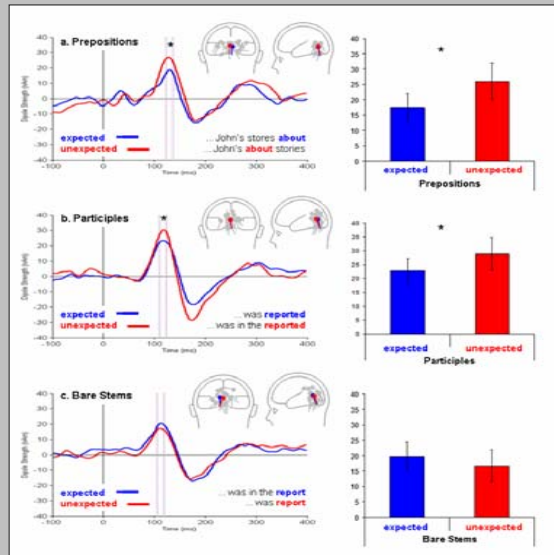
Experiment 1 tested 3 types of target words: Prepositions (closed-class, free morphemes), Participles (containing a closed-class, bound morpheme), and Bare Stems (containing no overt marking of word category).

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

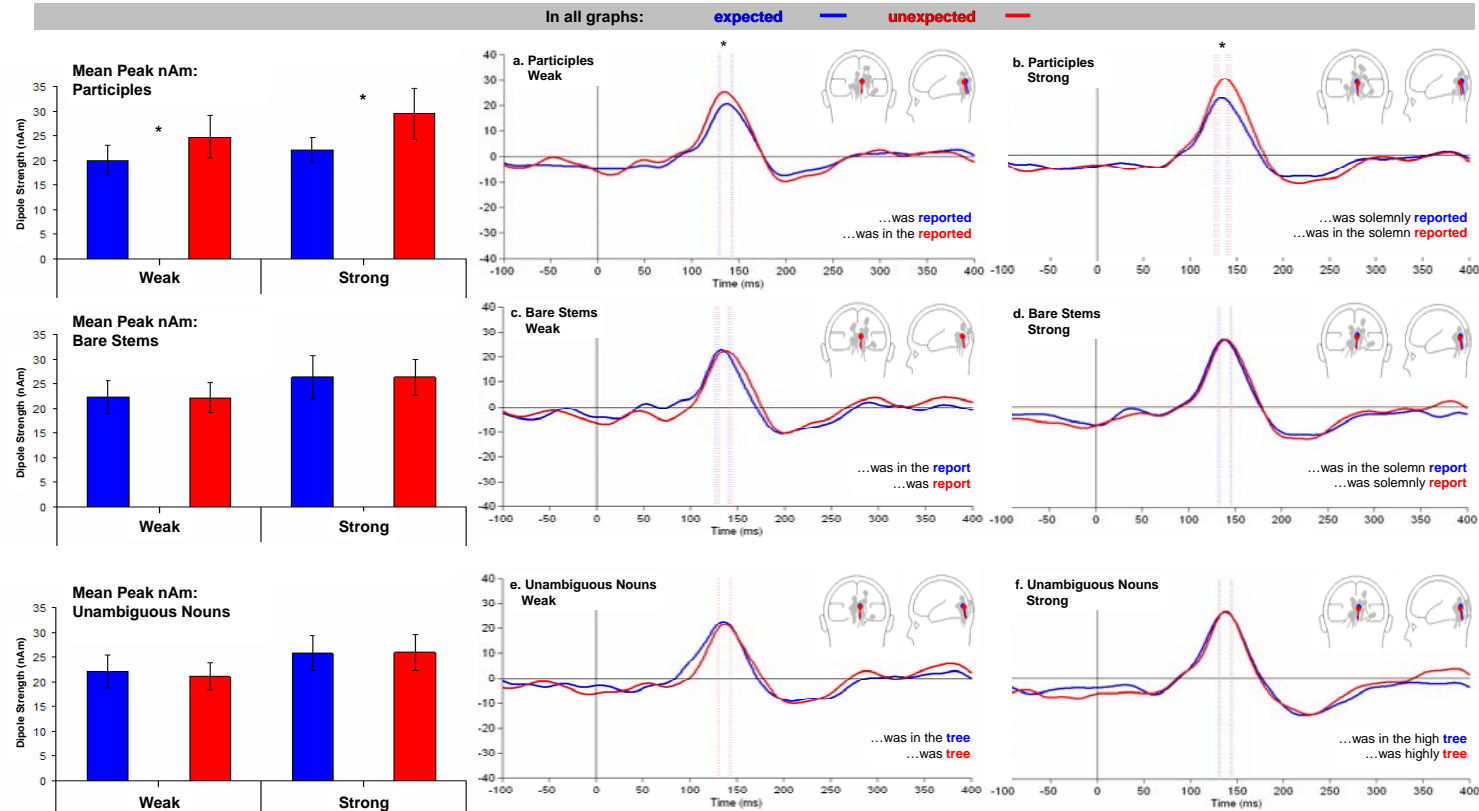
Possible explanations for the lack of an effect in the bare stem conditions:

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



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.