

# Grammatical anticipation?

## Neural dynamics of noun and verb processing

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### Introduction

- A wealth of evidence highlights (partially) dissociable neural systems responsible for processing nouns and verbs
- Noun processing recruits more strongly temporal brain areas and verb processing frontal brain areas (e.g., Vigliocco et al., 2011)
- This could reflect differences in action versus object semantics (e.g., Pulvermüller, 2013) or, alternatively, differences in lexical categories and syntactic operations (e.g., Shapiro et al., 2006).
- Much less research has been dedicated to the time-course of the cortical area activations between nouns and verbs and on the neural correlates elicited by the function words which typically precede an upcoming noun or verb.

### The current study

In the current study, several goals are pursued:

1. To characterize when an anterior-posterior cortical dissociation would be observed between noun and verb processing
2. To explore whether minimal sentential context, i.e. single function words, might influence such time-course
3. To use the evidence to constrain theoretical proposals concerning the organization of grammatical class in the brain.

**Work in progress** We present advanced data analysis and preliminary conclusions

### Experimental protocol

#### Design and procedure

Native speakers of French were asked to read covertly a pair of words per trial.

Each word (prime or target) was presented for 600 ms.

We contrasted nouns vs. verbs, in predictive vs. non-predictive contexts, plus catch trials.

The task required detecting pseudo-words in the catch trials *only*.

#### Stimulus selection procedure (lexique.org)

1. Words between 3 and 8 letters long filtered for frequency, absence of homographs, profanity
2. Filtered out incorrect word transitions (\*ta allure, "sa erreur, "je essaie), misplaced imperatives (je brille / brille [imp 2e])
3. Matched verbs to closed-class words for gender, number (place into bins), nouns to verbs for length, frequency, orthographic distance (old20), bigram frequency, number of phonemes
4. Check subjective naturalness ratings from 6 native speakers
5. Finally, 350 pairs with best naturalness ratings and closest lexical frequency match chosen
6. Additionally, 140 pseudowords generated using `lexique.org` toolbox to match orthographic and phonological properties of stimulus words. Used as catch trials, paired with closed-class words at random in proportion to normal stimuli.

#### Conditions

	Primes	Targets	No. of trials
Words	Possessive pronouns	Nouns	185
	Personal pronouns	Verbs	185
	Possessive pronouns	Catch	20
	Personal pronouns	Catch	20
Symbols	#####	Nouns	185
	#####	Verbs	185
	#####	Catch	20
	#####	Catch	20
		<b>Total</b>	<b>780</b>

### MEG data analysis

#### MEG and MRI preprocessing

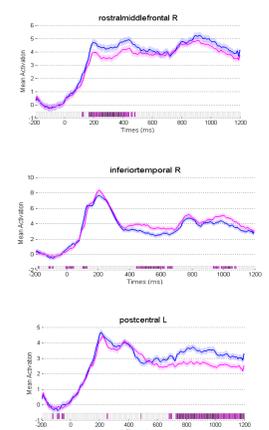
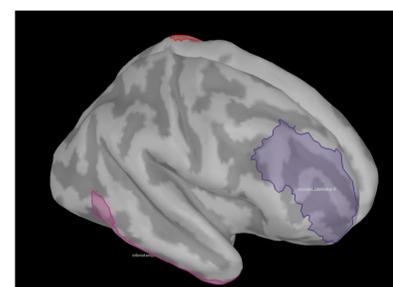
1. Cortical surface reconstructed using `FreeSurfer` software for each individual from high-resolution 3D T1-weighted MRI structural image
2. Cortical surface sampled to 15000 dipole locations using `Brainstorm`. This cortical surface served as the solution space for the estimated current generators (i.e. orientation constrained dipoles on gray matter)
3. Forward solution was calculated using a weighted minimum norm estimates approach.

#### Anatomical ROI analysis

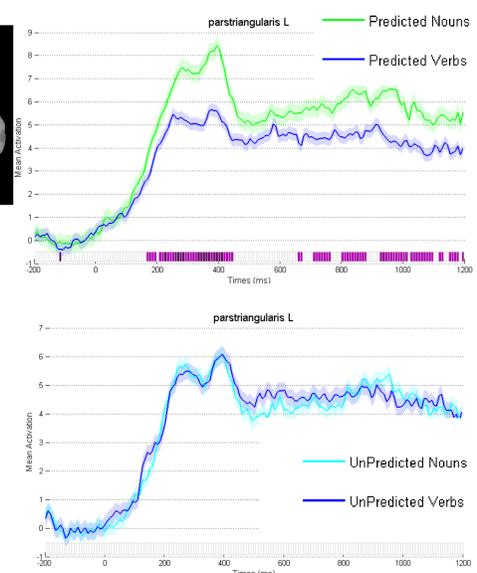
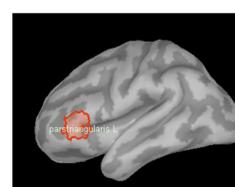
1. Subdivision of individual anatomy into regions of interest (ROI) based on the anatomical atlases of Desikan and Killiany (68 + 4).
2. For each subject and experimental condition, absolute average ROI time series extracted
3. Mass univariate analyses (with no *a priori* knowledge of effect location and latency): 2000 non-parametrical permutation tests (`EGLAB` toolbox, Delorme & Makeig, 2004) on each time point followed by corrections for multiple comparisons (False Discovery Rate, FDR; Bejamini & Yekutieli, 2001).

### Preliminary results

#### Main effect of predictability



#### Interaction of predictability and grammatical category



### Preliminary conclusions

- Grammatical predictability has a reliable effect
- Grammatical category reveals meaningful significant contrasts, but in an unexpected direction: Noun conditions more active than verb conditions in frontal areas.
- Further explorations of temporal lobe activity in progress.

### References

Data analysis was performed with `Brainstorm` (Tadel et al. 2011), which is documented and freely available for download online under the GNU general public license (<http://neuroimage.usc.edu/brainstorm>).