

Planning production: Morphological, semantic and syntactic representations

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Introduction

- Lexical, morphological, and phonological processing are viewed as separate processing levels in most models, yet their spatial and/or temporal dissociation is under-characterized.
- Invasive intracranial electrophysiology recordings have revealed selectivity for morphological processing in time and space during production.^{1,2}
- Given its spatial and temporal sensitivity and non-invasive nature, MEG is an ideal method for studying the stages of linguistic processing leading up to production in healthy brains.

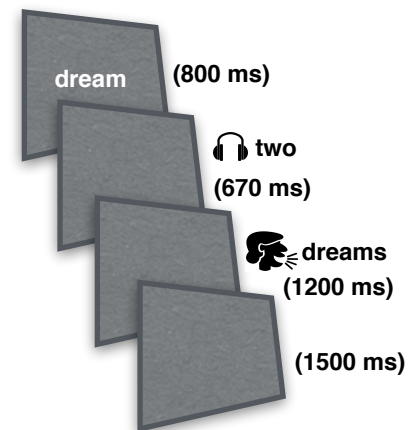
Research questions

- Do we observe an effect of abstract inflection, regardless of differences in phonology?
- Do we observe differences in activity based on syntactic category, independent of semantic properties and inflectional status?
- How are representations of inflectional, semantic, and syntactic features encoded in the brain over time?

Task: Phrase Completion

Task instruction: Complete the phrase with the appropriate form of the **noun / verb**

	prompt	cue	target	condition
Inflect (modify)	dreams	one / I	dream	no -s
	dream	two / he	dreams	+s
Inflect (same)	dream	one / I	dream	no -s
	dreams	two / he	dreams	+s
Repeat	dream	say	dream	no -s
	dreams	say	dreams	+s



24 right-handed native English speakers, 1080 trials

Design and Materials

3 inflection x 3 semantic x 3 syntactic

		Noun	Verb	Ambiguous
Inflect (modify) IN context + change the form of the	Abstract no physical referent	trait	adapt	dream
Inflect (same) IN context + no change to seen word	Movement non-manipulable motion	tornado	kneel	leap
Repeat NO context + no change to seen word	Manipulable manipulation by humans	sword	carve	hammer

Analysis

- Acquisition recording band 0-200Hz, sampling rate of 1000 Hz
- Epochs from 0 (cue offset) to 500 ms (average production)

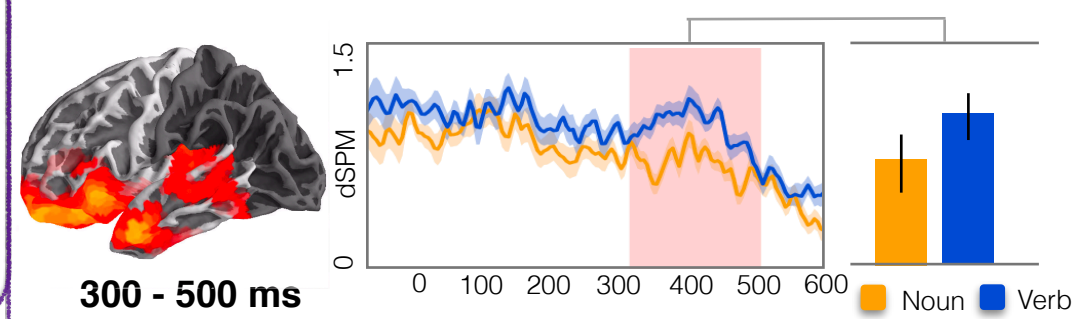
Spatiotemporal, Non-Parametric Permutation Tests

- Non-parametric cluster permutation ANOVAs performed from 100 to 500 ms across a left hemisphere mask, $p < 0.05$

Representational Similarity Analysis (RSA)

- Searchlight analysis through time (50 ms sliding windows) and space (10 mm of cortex around each source)
- Whole left hemisphere (0 - 500 ms), $p < 0.05$, FDR correction

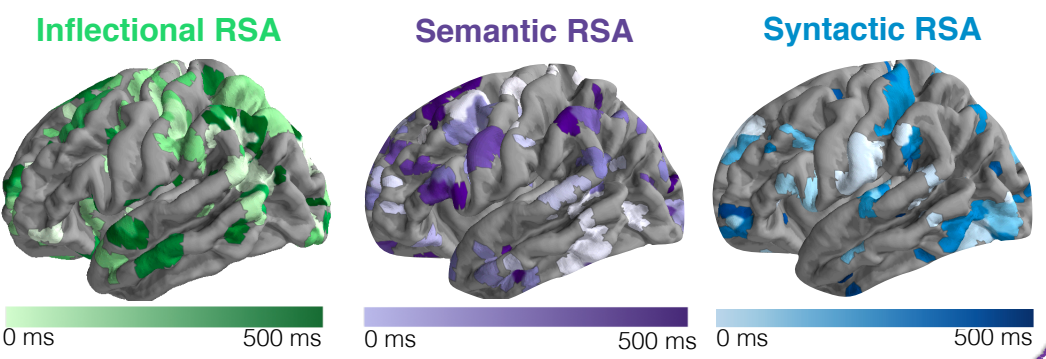
b) Difference in activity based on syntactic category^{3,4,5} regardless of other linguistic features (300 - 500 ms window)



* no significant interactions with semantic features or inflectional status

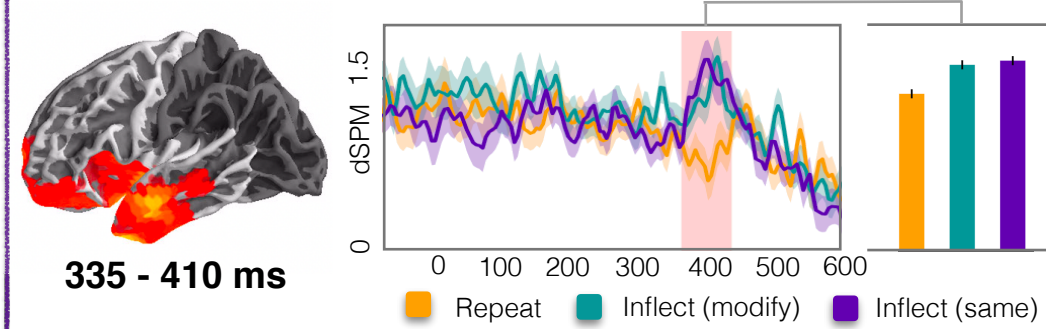
c) Representations of inflectional, semantic, and syntactic features encoded in the left hemisphere over time

Significant correlation with model matrix (extending for at least 25 consecutive ms) throughout the left hemisphere



Results

a) Effect of abstract inflection (independent of phonology) in 300-500 ms window*



* no significant interactions with semantic or syntactic features

Conclusions

1. We find evidence of abstract grammatical inflection during production in frontal and frontotemporal regions.
2. This effect is consistent across syntactic category, person/number and lexico-semantic properties, suggesting a unified inflectional system.
3. Detailed neural representations of inflectional, semantic, and syntactic properties can be probed using multivariate analyses at different time-scales over distinct anatomical regions.

References

¹ Sahin et al., 2009; ² Lee et al., 2018; ³ Shapiro, Moo, & Caramazza, 2006; ⁴ Bedny et al., 2008; ⁵ Bedny & Thompson-Schill, 2006