MEG masked priming evidence for early form-based decomposition of irregular past tense verbs

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Introduction

Past Tense Debate

1. Dual Mechanism Theory: regular verbs generated by rule, irregulars memorized and stored as whole forms in the lexicon.
   (Pinker & Prince, 1988)
2. Single Mechanism Theory: both regulars and irregulars generated by rule from stem and affix, with phonological readjustment of stem as necessary.
   (*Stockall & Marantz, 2006)*

Masked Morphological Priming

Behavioral evidence for form-based decomposition from masked priming with genuinely affixed words (teacher-TEACH) and pseudo-affixed words (corner-CORN), but not orthographic controls (brothel-BROTH; Rastle, Davis, & New, 2004).

Similar results for irregularly inflected items (fell-FALL), but not pseudo-irregulars (bell-BALL; Crepaldi et al., 2010).

MEG/EEG Studies of Visual Word Recognition

MEG studies of single word reading show effects of *transition probability from stem to affix* on the M170 evoked response (Solomyak & Marantz, 2010). Here, following up on previous EEG and MEG studies showing masked priming effects (Morris & Stockall, in press; Lehtonen, Monahan, & Poeppel, 2011), we ask whether we can find early effects of masked morphological priming (i.e. during the time window of the M170), even for irregularly inflected past tense verbs.

Design

Stimuli

• 200 real word targets, preceded by related and unrelated primes; the two types of primes are matched for word length, frequency, and orthographic neighbors.
• 200 non-word targets, preceded by real word primes (related and unrelated); non-words matched for length and orthographic neighbors with real word targets.

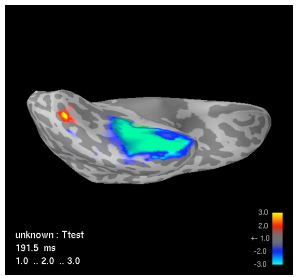
	Unrelated Prime	Related Prime	Target
Identity	busy	tree	TREE
Regular	ballet	rushed	RUSH
Irregular	rub	dug	DIG
Pseudo-irregular	cab	rug	RIG

Experimental Procedure

MEG Analysis

MEG Experiment:
•Right-handed native English speakers (n=16) completed a visual masked priming lexical decision task (word vs. non-word) consisting of 400 trials.
•MEG data was acquired continuously during the task.
•Structural MRIs were analyzed via FreeSurfer.
•Cortically-constrained inverse solutions were computed via MNE.

Priming Analysis via Fusiform/IT Functional ROI:
•Functional region of interest (ROI) was defined based on the peak priming effect for Identity + Regular conditions, within the left fusiform and inferior temporal (IT) ROIs.
•For the priming analysis, linear mixed effects models were employed millisecond-by-millisecond with the average activity within the ROI (for each trial) as the dependent variable, PrimeType (related vs. unrelated) as the fixed effect, and subject and item as random effects.



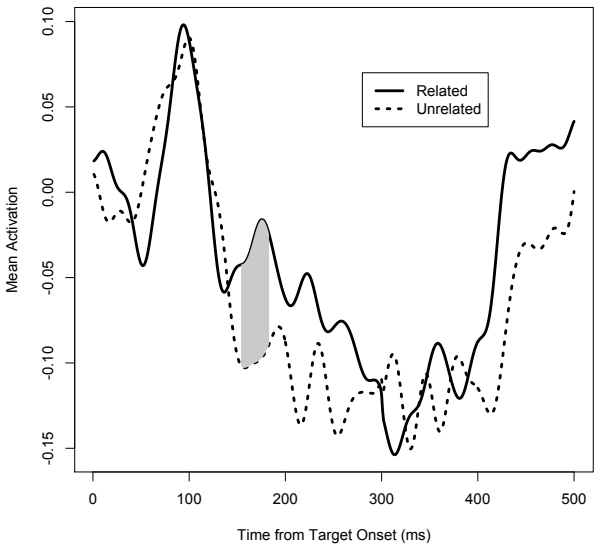
Left hemisphere of a representative subject's inflated cortical surface, from a ventral view. Priming effect for Identity + Regular conditions (across subjects) is shown at ~190 ms post-target onset, within the left fusiform and IT anatomical ROIs. The functionally defined ROI is highlighted in green.

Behavioral Results

	RT Priming
Identity	**33.3 ms (p = 0.0001)**
Regular	**22.5 ms (p = 0.002)**
Irregular	**14.2 ms (p = 0.042)**
Pseudo-irregular	**14.6 ms (p = 0.083)**

MEG Results

Irregular Priming Effects in Left Fusiform/IT Functional ROI



Priming Analysis	ROI / Hypothesized time window	Significance of effect*
Irregular	Functional ROI (Ident+Reg) / 150 – 300 ms	p = 0.044 for the cluster at 154-183 ms.
Pseudo-irregular	Functional ROI (Ident+Reg) / 150 - 300 ms	No effect.

*Significance calculated via 10,000 iterations of permutation tests, based on multiple comparisons correction algorithm in Maris & Oostenveld (2007), as adapted by Solomyak & Marantz (2010).

Conclusions

1. Early effects of masked priming manipulation in left fusiform/IT (i.e. the anatomical locus of the Visual Word Form Area).
2. Early priming effects for irregular verbs, supporting notion that **all** past tense verbs (regardless of regularity) are decomposed into stems and affixes, prior to lexical access.
3. Confirms predictions of Single Mechanism Theory (Stockall & Marantz, 2006), as opposed to Dual Mechanism Theory (Pinker & Prince, 1988) which predicts rule-based decomposition only for regular verbs.

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