

The Timecourse of Morphological Processing: An MEG Study



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Introduction

Models of lexical access differ in the timing of lexical decomposition. Taft & Forster (1975) originally proposed that affixes are stripped from morphologically complex words before lexical access. Recent masked priming research by Davis, Rastle & New (in press, *PBR*) provides further support for this model. In this study, we used Magnetoencephalography (MEG) to examine the time course of morphological decomposition.

The earliest MEG component that might show effects of morphology is the M170, as it has been identified as the first locus of letter-string specific processing (Tarkiainen et. al 1999, *Brain*). We tested 1. **whether the M170 shows effects of morphological complexity** and 2. **whether such an effect would be modulated by semantic transparency and/or frequency.**

Stimuli

We used 8 bins of 17 words each, based on two criteria – morphological complexity and surface frequency. Bins were controlled for length, orthographical neighborhood density and frequency, and syntactic category. The suffixed bins were further controlled for stem frequency and orthographical regularity. To increase signal-to-noise ratio in the MEG averages, the bins were merged in two different ways; (1), across the frequency divide, resulting in morphological bins controlled for surface frequency and, (2), across the sub-distinctions within the suffixed and non-suffixed bins, allowing the effects of frequency to be measured.

	No Suffix	No Suffix Orth. Matched	Opaque Suffix	Transparent Suffix
High Surface Freq. ~30 (K&F)	curtain	feather	sweater	painter
Low Surface Freq. ~2.5 (K&F)	convent	blunder	sneaker	charmer

	No Suffix	O. Match	Opaque	Transparent
H.Freq.	curtain,	feather,	sweater,	painter,
L.Freq.	convent	blunder	sneaker	charmer

	No Suffix	O. Match	Opaque	Transparent
H.Freq.	curtain, feather		sweater, painter	
L.Freq.	convent, blunder		sneaker, charmer	

Methods

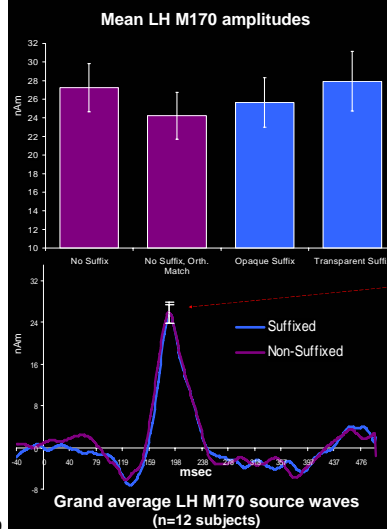
Subjects: 12 native English speakers.

Task: Lexical decision.

MEG recording: 148-channel neuromagnetometer (4-D Neuroimaging, Magnes WH 2500). Sampling rate: 678 Hz. Recording band: .1- 200Hz.

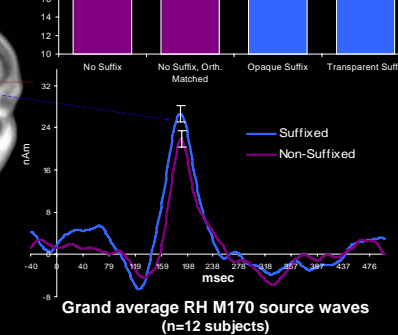
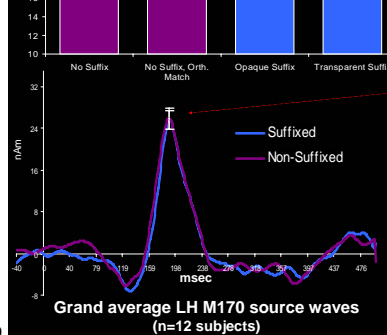
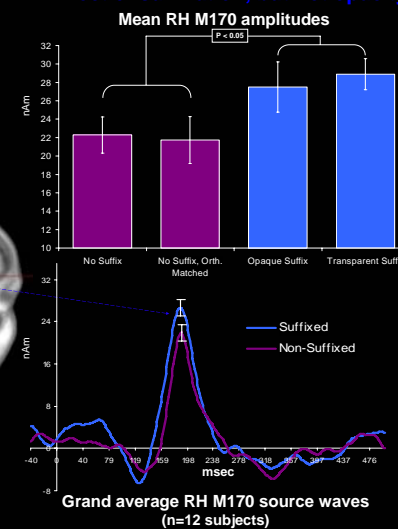
Data analysis: Due to significant overlap between the bilateral magnetic fields for early word-processing activity (M170), it is difficult to model the sources in the two hemispheres as separate dipoles using standard multi-dipole modeling. fMRI studies provide evidence that the left fusiform gyrus (Talairach coordinates $x=-42, y=-57, z=-6$) shows a letter-string effect (Cohen et al. (2000), Dehaene et al (2002)). Therefore, we placed dipoles in the fusiform gyri bilaterally. This is consistent with MEG localization when bilateral sources are obtained.

Left Hemisphere No effect of suffixation



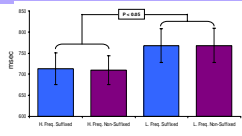
MEG Results

Right Hemisphere Effect of suffixation, but not opacity



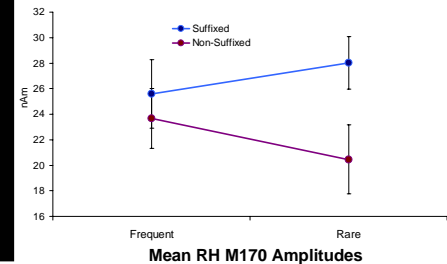
Behavioral Results

Response times to high frequency stimuli were reliably faster than to low frequency stimuli. No other behavioral effects were found.



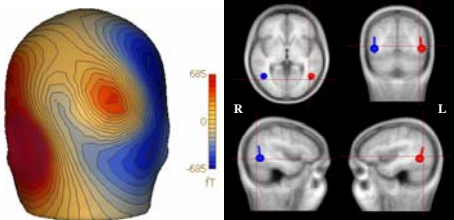
Frequency x Suffixation

No effect of frequency was found in either hemisphere. However, a marginal ($p = 0.09$) interaction between frequency and suffixation was found in the right hemisphere, suggesting that the suffixation effect found may occur primarily in low frequency words.



M170 Field Pattern

Left and right hemisphere M170 dipoles plotted in a standard MRI



Conclusion

These results show that M170 activity is influenced by the presence of derivational suffixes, lending support to the hypothesis that lexical decomposition occurs early. This effect is shown to be truly sensitive to morphology and not to orthographical homologues of the suffixes. It is also shown to occur regardless of the semantic opacity of the suffix, lending support to the view that all affixed words decompose. However, a possible interaction between frequency and affixation suggests that the affixation effect may be specific to low frequency words. Interestingly, our M170 effect is right lateralized. Given that previous MEG results (Tarkiainen et. al, 1999) show that letter-string effects are left-lateralized, this suggests that early visual word processing may be bilateral, with distinct functional roles for the left and the right hemispheres.