Individual differences in processing pseudo-inflected nonwords

Julia Schwarz, Mirjana Bozic, Brechtje Post

Department of Theoretical and Applied Linguistics, University of Cambridge, UK

Abstract

While the role of word stems has received much attention in morphological processing, the effects of inflectional suffixes on lexical access remain unclear. We address this gap as well as the contribution of individual differences on morphological segmentation with a visual priming experiment. Inflected and uninflected nonwords were preceded by a non-linguistic baseline string or the target's suffix/word-final letters (e.g. XXXXing → SMOYING). The results indicate that the suffix length is crucial for morphological effects to surface in visual priming and that morphological processing may be modulated by the individual's reading profile and vocabulary size. We interpret this as evidence for variable morphemic activation: morphological cues can facilitate visual access when rapid whole-word processing is unavailable. The theoretical implications are discussed.

Keywords: morphological priming, nonwords, individual differences

Introduction

Although the use of morphological information in visual word processing is well-documented (Amenta and Crepaldi 2012), the limited research on inflection priming effects (in contrast to stem and derivational priming) is inconclusive and raises questions about the mechanisms involved in accessing inflectional suffixes. In English, only two studies have investigated inflection priming, and only in the auditory domain: in contrast to Emmorey (1989), who did not find a significant morphological effect for the inflections *-ing*, *-ed* and *-es*, recently Goodwin Davies and Embick (2019) did find significant priming for plural nouns.

In this paper, we investigate the role of inflections through visual suffix priming in nonwords. Nonwords cannot be stored in the mental lexicon and as such allow us to reduce semantic interference from stems and instead focus on the inflections in question. In addition, we were interested to see whether morphological priming effects in nonwords are dependent on subjects' reading skill and the size of their existing lexicon, as measured by their response speed and error rate. Medeiros and Duñabeitia (2016) found that morphological effects in visually presented derived words were indeed modulated by individual reading speed: only slow readers, who have a lower level of orthographic skill, displayed a morphological priming effect. Similar effects could apply to

inflected words. Furthermore, vocabulary size and subjects' reading skills are likely to affect processing of novel information such as nonwords.

We hypothesized that a high error rate, which has been related to lower vocabulary knowledge (Yap, Balota, Sibley, Ratcliff 2012), as well as slower reading speed (Medeiros and Duñabeitia 2016) could lead to a stronger dependency on morphological information, given that automated whole-word processing necessitates rapid orthographic decoding. Breaking down unfamiliar items into more meaningful sub-lexical units might therefore facilitate reading for subjects with lower orthographic and vocabulary skills.

Methods

The online experiment was set up in Psytoolkit (Stoet 2010, 2017). Pseudo-inflected nonwords were preceded by suffix primes embedded in a non-linguistic string (e.g. XXXXing → SMOYING). Each trial consisted of a row of hashmarks, a 150ms prime, and a lexical decision task to the target word. We tested three English inflections, varying in orthographic length: the plural inflections *-s* and *-es*, and the verbal inflection *-ing*, each matched with uninflected controls (e.g. XXXXgle → SHANGLE). The 288 nonwords were created from the real word targets used in the lexical decision task and matched on the number of letters and syllables, phonological shape, number of orthographic neighbours, and bigram frequency, resulting in a well-balanced data set of phonotactically legal items.

Reaction times from 80 native English speakers were log-transformed and analyzed in R by fitting linear mixed effects models with subject and item random intercepts for each suffix type (vs. uninflected orthographic controls). P-values were calculated with the Satterthwaite approximation for degrees of freedom. Mean reaction times and error rates per participant were calculated based on the cleaned data set and then rescaled and centred.

Results

Our results indicate that inflected nonwords can be primed with suffixes presented in isolation. However, this depended on the type/length of the primes and participants' response patterns. The optimized models fitted individually for nouns with an *-s* suffix and nouns with an *-es* suffix did not show effects of priming or morphological complexity. Since items and controls were closely matched, and since there was also no significant priming or inhibition for orthographic controls, it is likely that the length of the prime is crucial for a reliable visual priming effect.

However, the orthographically longest prime, the *-ing* suffix, showed significant priming compared to simple controls of the same length (-3ms vs. +15ms). In addition to a significant interaction between priming and morphological complexity (b=.02, $t(6157)=2.15$, p=.031), the best model also included subjects' mean reaction time (b=.14, $t(73)=31.86$, p<.001) and a three-

way interaction between priming, morphological complexity, and subjects' error rates (b=.03, $t(6164)$=4.01, p<.001).

Following a median-split comparison, we further investigated the effects of error rates and response speed on morphological priming in the 3-letter overlap condition (*-ing* vs. simple targets). We found that only subjects with a high error rate, which could indicate a smaller lexicon size, showed morphological priming effects of suffixed targets (-13ms, b=.04, $t(2859)$=2.70, p=0.007; Figure 1, left). In addition, only slow readers, indicated by their mean response time, displayed morphological priming (-10ms, b=.03, $t(3038)$=2.18, p=.029; Figure 1, right). The inhibitory effect found for uninflected targets was unaffected by reaction times and error rates.
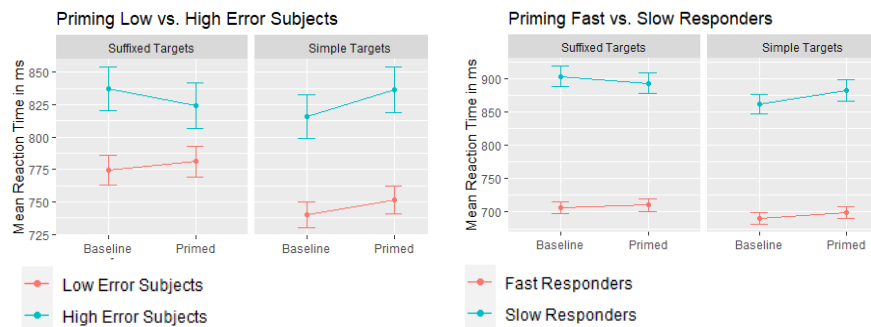

Figure 1. Priming effects for the *-ing* suffix, shown as a function of error rate and response speed.

Discussion

If inflectional suffixes play no role as sub-lexical units in visual access, no priming difference between inflections and orthographic controls should emerge, nor should there be any differences between subjects with different reading profiles and lexical knowledge. We found that the opposite was the case in our study, at least for the longest and therefore most salient inflection.

Specifically, the results suggest that the effects of morphological cues in the visual modality are dependent on both linguistic factors and individual variables. Firstly, nonwords were affected differently by a prime dependent on the affix structure; nonwords inflected with the *-ing* suffix were facilitated by a prime, whereas uninflected controls were inhibited. Secondly, morphological priming was modulated by subjects' response speed and error rates. Only subjects with high error rates and slow responses displayed morphological facilitation for suffixed targets. These results are in line with previous research which found that priming differences between morphologically derived and simple targets only emerged for readers with lower proficiency (Beyersmann, Casalis, Ziegler, Grainger 2015, Medeiros and Duñabeitia 2016). It seems that subjects with a smaller vocabulary (indicated by errors) and lower orthographic

processing skill (indicated by response speed) might be less efficient in mapping orthography onto meaning directly and as such are more likely to engage decomposition mechanisms.

Overall, the results indicate that morphemic chunks can facilitate lexical identification, especially for lower-skilled readers. We suggest that this reflects morphological processing as a sub-lexical strategy when direct mapping is unavailable. This finding is most consistent with parallel-route models, which allow competition between direct access and decomposition (e.g. Baayen and Schreuder 1999).

Acknowledgements

References

Amenta, S., Crepaldi, D. 2012. Morphological processing as we know it: An analytical review of morphological effects in visual word identification. Frontiers in Psychology 3, 232.

Baayen, H., Schreuder, R. 1999. War and peace: Morphemes and full forms in a noninteractive activation parallel dual-route model. Brain and Language 68(1-2), 27-32.

Beyersmann, E., Casalis, S., Ziegler, J., Grainger, J. 2015. Language proficiency and morpho-orthographic segmentation. In Psychonomic Bulletin & Review 22(4), 1054-1061.

Emmorey, K. 1989. Auditory morphological priming in the lexicon. Language and Cognitive Processes 4(2), 73-92.

Goodwin Davies, A., Embick, D. 2019. The representation of plural inflectional affixes in English: evidence from priming in an auditory lexical decision task. Language, Cognition and Neuroscience 60, 1-9.

Medeiros, J., Duñabeitia, J. 2016. Not everybody sees the ness in the darkness: Individual differences in masked suffix priming. Frontiers in Psychology 7, 1-10.

Stoet, G. 2010. PsyToolkit - A software package for programming psychological experiments using Linux. Behavior Research Methods 42(4), 1096-1104.

Stoet, G. 2017. PsyToolkit: A novel web-based method for running online questionnaires and reaction-time experiments. Teaching of Psychology 44(1), 24-31.

Yap, M., Balota, D., Sibley, D., Ratcliff, R. 2012. Individual differences in visual word recognition: insights from the English Lexicon Project. In Journal of experimental psychology. Human Perception and Performance 38(1), 53-79.