

## Effects of affix ordering in processing: EEG evidence from Bengali

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Despite mounting evidence for the importance of morphological structure in the mental lexicon and decomposition in processing, a consensus on which factors affect the processing route taken and the degree of activation of morphologically related items has not been reached. One area which has not been investigated extensively yet is the role played during processing by the internal structure of multiply complex morphological items. Of particular interest in the current study is the order of affixation in items of the type prefix+stem+suffix (e.g. *[[un-kind]-ness]* vs. *[un-[faith-ful]]*), which are not necessarily constructed linearly. Asymmetries in the processing of such items could be expected to arise if the parser takes into account selection restrictions arising from the input so far (e.g., the prefix *un-* requires an adjective) and thus will not search the lexicon for mismatching candidates (*\*unfaith*), instead anticipating further input. However, previous behavioural research (e.g. Libben 1993, 2006; Song et al. 2019) reports contradictory results on whether order of affixation affects access to the stem in multiply complex items.

The present study employs a cross-modal priming paradigm (auditory primes and visual targets) with EEG. Previous work (reviewed by Leminen et al. 2019) has shown that priming with morphologically related words often produces N400 attenuation (e.g. Coch et al. 2012), while LAN effects may be associated with problematic or resource-intensive decomposition processes (e.g. Bölte et al. 2009). Here, we use ERPs to investigate whether listeners are sensitive to affix ordering and selection restrictions in language processing.

A cross-modal lexical decision task with EEG was conducted using Bengali trimorphemic items as primes and the corresponding stems as targets (see Table 1 for sample stimuli). The experiment consisted of two morphological conditions as well as semantically- and form-related conditions with 24 prime-target pairs per condition. All primes were matched with unrelated control primes. Items in the morphological conditions differed in the order of affix attachment: (i) **prefix-first**: *[[prefix+stem]+suffix]* (as in *unkindness*) and (ii) **suffix-first**: *[prefix+[stem+suffix]]* (as in *unfaithful*). 24 native Bengali speakers participated in the experiment conducted at Jadavpur University, Kolkata, India resulting in 1152 trials per condition of which half were related.

Linear mixed effects modelling of EEG amplitudes in the 280–330ms time window (centred around the average maximum peak) after target presentation showed an interaction between relatedness condition and trial type (control vs. prime) in the centro-parietal and fronto-central regions, with this N400 effect being more pronounced in both the prefix-first ( $\beta = 1.44$ ,  $t(2544) = 4.40$ ,  $p < .001$ ) and suffix-first ( $\beta = 1.78$ ,  $t(2544) = 5.43$ ,  $p < .001$ ) conditions compared to the form condition. In the 400–700ms window, differentiation emerged between the morphological conditions: specifically, an interaction between relatedness condition and trial type was driven by the prefix-first condition, which showed a more pronounced decrease in amplitude between the control and prime conditions compared to the Form condition ( $\beta = 1.09$ ,  $t(17990) = 3.25$ ,  $p = .001$ ), while the suffix-first condition did not ( $\beta = -0.36$ ,  $t(17990) = -1.08$ ,  $p = .281$ ).

These results show listeners' sensitivity to the order of attachment of affixes. While there is comparable activation of the lexical entry in both morphological conditions (N400 results), the later effect (LAN) shows that access to the stem recruits more resources in the prefix-first condition. This indicates that in this condition accessibility of the stem is reduced as it is not the first constituent to be encountered in the embedded structure (compare *faith-ful* vs. *un-kind*) after stripping of the last-added affix. Thus, listeners show sensitivity to the underlying morphological structure and the properties of the affixes involved even though the complex items are superficially identical.

**Table 1** Sample stimuli for all four related conditions

Condition	Prefix-first	Suffix-first	Semantic	Form
Prime	ɔkoᵗʰito	ɔpurnota	ɔpraᵗʃurɔɔ	kompɪɔ
	ɔ-kɔᵗʰ-ito	ɔ-purno-a	ɔ-proᵗʃur-ɔɔ	kɔmp-ito
	åkèèiTt	åpUåRåTÅ	åŠÅåcuèyR	kiiµiØt
	'unspoken'	'emptiness'	'dearth'	'shivering'
Target (stem)	kɔᵗʰa	purno	ɔbʰab	piᵗa
	kùTA	pUåR	åBèAb	iptÅ
	'word'	'full'	'poverty'	'father'

### References

- Bölte, J., Jansma, B. M., Zilverstand, A., & Zwitserlood, P. (2009). Derivational morphology approached with event-related potentials. *The Mental Lexicon*, 4, 336–353.
- Coch, D., Bares, J., & Landers, A. (2012). ERPs and morphological processing: the N400 and semantic composition. *Cognitive, Affective, & Behavioral Neuroscience* 13, 355–370.
- Leminen, A., Smolka, E., Duñabeitia, J. A., & Pliatsikas, C. (2019). Morphological processing in the brain: The good (inflection), the bad (derivation) and the ugly (compounding). *Cortex*, 116, 4–44.
- Libben, G. (1993). A case of obligatory access to morphological constituents. *Nordic Journal of Linguistics*, 16, 111–121.
- Libben, G. (2006). Why study compound processing? An overview of the issues. In: G. Libben and G. Jarema (eds.), *The representation and processing of compound words*, pp. 1–22. Oxford: Oxford University Press.
- Song, Y., Do, Y., Lee, J., Thompson, A. & Waegemaekers, E. (2019). The reality of hierarchical morphological structure in multimorphemic words. *Cognition*, 183:269–276.

### **Information on affixation in Bengali:**

As an Indo-European language, Bengali is broadly similar to well-studied Germanic languages such as English and German in terms of affixation patterns but allows for the construction of a more tightly controlled stimulus set in certain respects for the following reasons:

- (i) most derivational affixes in Bengali have a similar provenance and thus the language does not show the same division as Germanic languages between borrowed and inherited affixes
- (ii) While generally assimilations between prefix and stem are less frequent than for suffix and stem, Bengali morphophonological assimilation rules apply equally to both prefixed and suffixed domains which means that one category is not more discrete than the other.
- (iii) stress patterns are also very consistent with overwhelmingly word-initial stress.