

Vowel raising in Bengali inflectional morphology: Interactions of orthography and phonology in processing

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This study examines the processing of Bengali inflected verb forms and their stems in instances where the stem vowel is subject to a phonologically conditioned, predictable vowel alternation. Stem vowel alternations are common across languages in inflectional paradigms (e.g. English *keep* [ki:p] ~ *kep-t* [kɛp-t]; German *geb-en* [geb-ən] 'give-INF' ~ *gib-st* [gib-st] 'give-2P.SG'). In Bengali, the stem vowels /æ, e, ɔ, o/ in verbs, undergo step-wise raising in the context of the first person (1P) suffix /-i/ to /e, i, o, u/ (e.g. [lek^h-e] 'write-3P.PRES' ~ [lik^h-i] 'write-1P.PRES') while the stem vowel /-a/ is unaffected ([mar-e] 'beat-3P.PRES' ~ [mar-i] 'beat-1P.PRES'). Furthermore, not all vowel alternations are represented orthographically (cf. Table 1). As it has been shown that orthography and phonology interact in lexical access (cf. Taft 2011), the question arises to what extent the recognition of Bengali inflected forms is affected by this interaction. The above alternation provides three different conditions (24 items per condition): (i) the stem vowel remains the same (*NoDiff*), (ii) the stem vowel is raised but the orthography remains the same (*PronDiff*) and (iii) both orthography and phonology of the stem vowel change (*OrthPronDiff*). We thus ask the following:

- (a) Does the difference in the quality of the stem vowel affect access to the mental representation?
- (b) Does difference in orthographic representation affect lexical access?

Previous research on phonological differences has not revealed any difference in facilitation compared to phonologically transparent pairs, both with and without concomitant orthographic differences (e.g. English: *serene* > *serenity*, Marslen-Wilson et al. 1994; German: *Sohn* 'son' ~ *Söhn-e* 'son-PL', Lahiri & Reetz 2010). However, investigating German plurals, Scharinger et al. 2010, found a stronger EEG mismatch negativity for stems preceded by forms with a raised vowel.

To investigate whether the three types of surface relationship affect access to the lexical representation, we conducted two experiments with the same set of stimuli: a cross-modal lexical decision task (n = 34) with auditory primes (1P and 3P forms) and visual targets (verbal noun; e.g. [lek^ha]) and a forced-choice eye-tracking experiment (n = 26) with auditory fragments (CV of 1P or 3P form) and visual targets (full 1P & 3P form; cf. Table 1), with a fragment completion task.

As expected Ex1 showed no interaction but 3P primes (which overlap with the stem to a greater degree due to the lack of raising) result in greater facilitation than 1P primes in all conditions. In Ex 2, manual response data only shows reliable identification for *OrthPronDiff*, but eye movements clearly indicate that participants are able to match targets to fragments in both *PronDiff* and *OrthPronDiff* conditions. Eye movement patterns in both conditions are clearly different from the *NoDiff* condition, where both visual targets are potential matches, but indicate that the match is easier to make in the *OrthPron* condition compared to the *PronDiff* condition. Responses to 1P vs 3P only differed in the shape of the eye movement patterns, not the overall portion of looking at target vs. distracter.

Taken together, results show effects of both phonology and orthography on lexical access of morphologically related items. While manual responses in Ex 2 are at chance, the subtle effect is revealed by eye movements which show that vowel alternation makes the *PronDiff* condition more "decidable" than the *NoDiff* condition. Thus, our results indicate that listeners' access is guided by both types of information as well as by activation of the morphological paradigm the items belong to.

Table 1 Sample stimuli for Experiments 1 and 2

Condition	Exp 1: Cross-modal lexical decision task						Exp 2: Forced-choice eye-tracking					
	NoDiff		PronDiff		OrthPronDiff		NoDiff		PronDiff		OrthPronDiff	
	low vowel /a/		low-mid		mid-high		low vowel /a/		low-mid		mid-high	
	3P	1P	3P	3P	1P	3P	3P	1P	3P	3P	1P	3P
Prime	mar-e	mar-i	khæ-l-e	khel-i	lek ^h -e	lik ^h -i	ma-	ma-	khæ-	khē-	le-	li-
Target	mar-a		khæ-l-a		lek ^h -a		mar-e	mar-i	khæ-l-e	khel-i	lek ^h -e	lik ^h -i
	mArA		eKlA		eIkA		mAer	mAir	eKel	eKil	eleK	iliK
	'hitting'		'playing'		'writing'							
Distracter							mar-i	mar-e	khel-i	khæ-l-e	lik ^h -i	lek ^h -e

References

- Lahiri, A. & Reetz, H. (2010). Distinctive features: Phonological underspecification in representation and processing. *Journal of Phonetics*, 38, 44-59.
- Marslen-Wilson, W., Tyler, L. K., Waksler, R., & Older, L. (1994). Morphology and meaning in the English mental lexicon. *Psychological Review*, 101(1), 3–33.
- Scharinger, M., Lahiri, A., & Eulitz, C. (2010). Mismatch negativity effects of alternating vowels in morphologically complex word forms. *Journal of Neurolinguistics*, 23(4), 383–399.
- Taft, M. (2011). Orthographic influences when processing spoken pseudowords: theoretical implications. *Frontiers in Psychology*, 2(140), 1-7.