Predictability and phonological context interact in conditioning the acoustic reduction of Seoul Korean lenis obstruents

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This study investigates the interaction between the sources of the acoustic reduction of Seoul Korean (SK) lenis obstruents using a spontaneous speech corpus [1]. Regarding factors that affect obstruent reduction, [2] has found that obstruents are cross-linguistically reduced next to lower vowels and claimed that if speakers shorten the distance articulators travel to produce an obstruent constriction more between lower than higher vowels, they are trying to reduce articulatory effort. Alternatively, obstruents are reduced more when they are more predictable, e.g., in a more frequent word or in a higher transitional probability context and [3, 4] have claimed that this is because they are less informative there. While decreasing articulatory effort or reflecting usage are not mutually exclusive explanations, their predictions have not been tested on the same data [5, 6], nor have their interactions been explored.

This study addresses this gap by investigating a spontaneous speech corpus of SK [1]. Lenis obstruents in SK are optionally and gradiently voiced intervocalically within the prosodic constituent called the Accentual Phrase (AP) [7]. They are also reduced [8] and deleted [9] in the same prosodic position, though factors affecting lenis obstruent reduction other than prosodic position are less explored. Lenis obstruents have previously been shown to reduce more between low than higher vowels [8, 9], which suggests that speakers try to reduce effort, but these studies examined much less data than this study (e.g., 485 tokens in [9] vs. 98,418 in this study) and did not control for other factors known to affect lenis obstruent reduction, e.g., speech rate [7]. In this study, the gradient degree of acoustic reduction of lenis obstruents was measured following [5, 6, 10]. Using the forced-aligned phone segmentation in the corpus, the intensity was measured during the transitional interval from the preceding vowel to each lenis obstruent in Praat. Then, the negative extreme falling velocity was computed from the smoothed intensity contour. A faster fall in intensity indicates a full closure, whereas a slow fall indicates that the obstruent is reduced, as it means that the intensity of the lenis is not much different from the preceding vowel. This variable named 'Closure Velocity Extremum' was used as the response variable in a mixed-effects linear regression model (Table 1). [10, 11] have argued that the slower fall in intensity is caused by duration shortening, and an alternative model fit for the obstruent duration yielded generally the same results as in Table 1.

First, lenis obstruents were more reduced in the lexical word medial position than in the medial position (Table 1a). Under the reasonable assumption that lexical word medial syllables are produced in the prosodic constituent medial position, this corroborates the previous result that lenis obstruents are AP-medially reduced [8, 9]. However, they were more reduced when the preceding vowel was higher, contra [8, 9] (1c-d). The pairwise post-hoc test revealed that the mid and the low preceding vowels did not differ significantly. In contrast, lenis obstruents were progressively more reduced before low, mid, and high following vowels (1e-f). The asymmetry of preceding and following vowel contexts suggests that speakers' trying to reduce effort does not fully predict the reduction of lenis obstruents [5]. On the other hand, lenis obstruents were more reduced in a lexical word that appeared more often in the present corpus (1g), and if the transitional probability of current syllable given the previous syllable was higher in the present corpus (1h). In particular, the transitional probability traded off with the vowel height (Fig 1): as the transitional probability was higher, the preceding high vowel effect diminished (Fig 1A), but the following low vowel effect became larger (Fig 1B).

In conclusion, the results here contradict the explanation that speakers reduce obstruents to reduce articulatory effort [2] but are consistent with the explanation that speakers reduce obstruents in less informative contexts [3, 4] and in the prosodic medial position [7]. In addition, the phonological (vowel height) contexts and the transitional probability were found to interact in conditioning the degree of obstruent reduction in SK, which calls for further investigation.

Dependent variable: Closure Velocity Extremum (More negative CVE = Less reduction)				
Predictors (Contrast)	Coef	SE	t	Perspective
(a) Lexical word initial (+Initial -**Medial**)	-0.36	0.004	-81.6	✓Prosodic position
(c) Prec. vowel height 1 (+Low -**Else**)	-0.04	0.003	-10.7	✗**Art. effort**
(d) Prec. vowel height 2 (+Mid -**High**)	-0.06	0.003	-16.4	✗**Art. effort**
(e) Foll. vowel height 1 (+**Low** -Else)	0.14	0.004	34.4	✓Art. effort
(f) Foll. vowel height 2 (+**Mid** -High)	0.08	0.004	22.0	✓Art. effort
(g) Lexical frequency in the corpus	0.09	0.007	12.0	✓Usage-based
(h) P(current σ|previous σ) (Trans Prob)	0.01	0.004	2.8	✓Usage-based
Observations: 98,418, Marginal R^2: 0.340, Conditional R^2: 0.457				

Table 1. An excerpt from the linear mixed effects regression model result. The model also contained: Word-final syllable onset (functional status of the morpheme), Utterance speech rate, Local speech rate, Age, Gender, Place (4 levels, Helmert-coded), by-speaker random intercept, by-word random intercept. Interaction terms depicted in Figure 1 are omitted from the table. All terms in Table 1 were significant (p<0.05). For each contrast (a-f), the context where lenis obstruents are more reduced is bolded.
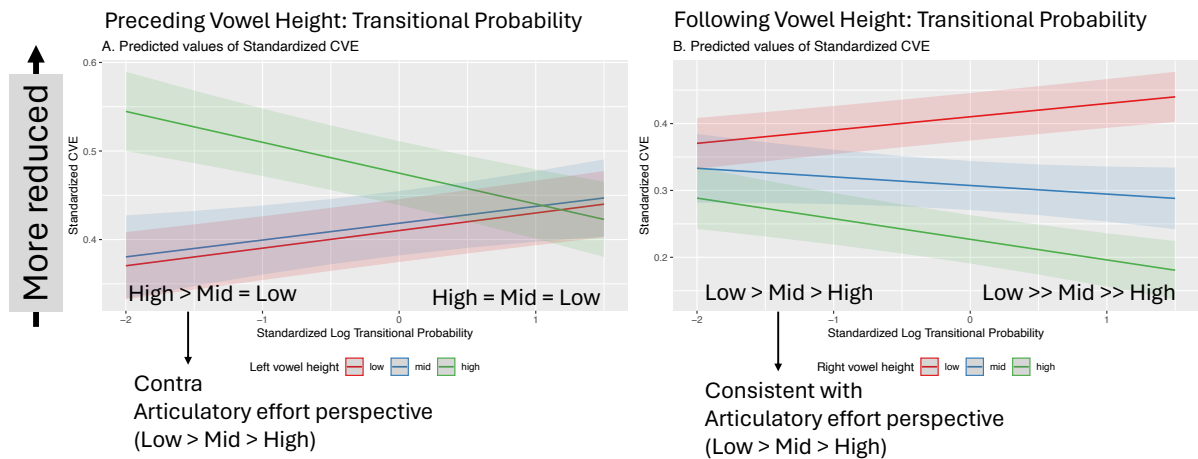
Figure 1. A-B Depiction of the interaction between Preceding/Following vowel height and Transitional Probability. Higher CVE means more reduced. Ribbons show confidence intervals.

References

[1] Yun et al. (2015). The Korean Corpus of Spontaneous Speech. *Phonetics and Speech Sciences*. **[2]** Kirchner, R. M. (1998). *An Effort Based Approach to Consonant Lenition* [Ph.D.]. UCLA. **[3]** Jurafsky et al. (2001). Probabilistic relations between words: Evidence from reduction in lexical production. *Frequency and the Emergence of Linguistic Structure*. **[4]** DiCanio et al. (2022). Extreme stop allophony in Mixtec spontaneous speech: Data, word prosody, and modelling. *JPhon*. **[5]** Kingston, J. (2008). Lenition. *Selected Proceedings of the 3rd Conference on Laboratory Approaches to Spanish Phonology*. **[6]** Ennever et al. (2017). A replicable acoustic measure of lenition and the nature of variability in Gurindji stops. *LabPhon*. **[7]** Jun, S.-A. (1998). The Accentual Phrase in the Korean prosodic hierarchy. *Phonology*. **[8]** Lee, S.-H. (1995). Reduction of velar lenis stops in Korean. *Journal of Linguistics*. **[9]** Kim et al. (2016). Patterns of consonant deletion in the word-internal onset position: Evidence from spontaneous Seoul Korean speech. *Phonetics and Speech Sciences*. **[10]** Katz, J., & Pitzanti, G. (2019). The phonetics and phonology of lenition: A Campidanese Sardinian case study. *LabPhon*. **[11]** Cohen Priva, U. & Gleason, (2019). The causal structure of lenition: A case for the causal precedence of durational shortening. *Language*.