Differential effects of prosodic boundary on glottalization of word-initial vowels in Korean: A preliminary report

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Voice quality is often described in terms of vocal fold approximation along a continuum [1], with voiceless sounds [ʔ] and [h] positioned at opposite ends. It is widely recognized that voice quality, including glottalization ([ʔ]), is influenced by prosodic structure, such as larger prosodic junctures or prominence [2,3,4], highlighting the phonetics-prosody interface. For instance, word-initial vowels tend to exhibit more glottalization at the onset of an Intonational Phrase (IP) compared to within the IP, serving as markers for prosodic boundaries. However, in English, glottalization is often associated with prominence rather than boundary marking [4]. This raises questions about the specific role of glottalization in marking prosodic structure, considering the interplay between boundary and prominence marking in different languages. Additionally, glottalization of word-initial vowels can also serve to avoid vowel hiatus across word boundaries [cf. 5], which may not be directly related to prominence or higher prosodic junctures. Our study focuses on Korean, where prominence marking is closely tied to boundary marking as an edge-prominence language [6], aiming to explore how glottalization, along with the temporal variation (preboundary lengthening, pause), operates within the phonetics-prosody interface. Furthermore, we investigate the influence of syntactic structure on phonetic implementation to examine if and how the phonetics-prosody interface can be further modulated by syntactic structure, particularly in the context of syntactic disambiguation.

In this study, we conducted an acoustic experiment with a group of fourteen native Seoul Korean speakers. The participants read sentences containing vowel-initial target words, including proper nouns (N1, N2, N3, such as /ali/, /aʧi/, /ami/), conjunction suffix /-hako/ ('-and'), and conjunction /animjʌn/ ('or') in syntactically ambiguous coordinate structures, as described in Table 1. These sentences were produced under various focus conditions, allowing for enriched contexts that facilitate the observation of interactions among phonetics, prosody, and syntax. (For simplicity, the focus-related effects are not reported in this study.) We measured H1*-H2* (degree of glottalization) and HNR (noise-related measure) of word-initial vowels for N2 and N3, as well as for the conjunction /animjʌn/. Additionally, we analyzed the duration of the syllable preceding the prosodic juncture, as well as the pause duration. The determination of prosodic boundaries (IP or Word (Wd)) was made collectively by all three authors.

Table 1. An example of test sentences with different syntactic contexts. Proper nouns (/ali/, /aʧi/, /ami/) could be placed in all three locations: Noun1 (N1), Noun2 (N2), Noun3 (N3).

	Q: musɨn ilija	"What's happening?"
Early Closure	A: a (N1-hako) (**N2 animjʌn N3**)-ka ontɛ	"Well, (N1-and) (N2 or N3) are coming."
	Q: musɨn ilija	"What's happening?"
Late Closure	A: a (N1-hako **N2**) **animjʌn** (**N3**)-ka ontɛ	"Well, (N1-and N2) or (N3) are coming."

Our prosodic analysis revealed a consistent mapping between syntactic juncture and prosodic boundary, as depicted in Fig.1a. Specifically, for Early Closure, an IP boundary consistently aligned with the syntactic juncture with Phrasing Type 1 ([N1-and] # [N2 or N3]), and for Late Closure with Phrasing Type 2 or Phrasing Type 3 (e.g., ([N1-and N2] # or **(#)** [N3]) where '(#)' denotes an optional boundary). Importantly, however, our results also demonstrated differential effects of the same type of prosodic boundary on the phonetic implementation, relative to the syntactic structure. Regarding temporal variation, the temporal expansion (preboundary lengthening + pause) was more prominent for IP boundaries in Early Closure parsing compared to Late Closure parsing. It was greater for the Phrasing Type 1 (i.e., [N1-and] **#** [N2 or N3], Fig.1b) than for the Phrasing Type 2/3, (i.e., [N1-and N2] **#** or (#) [N3], Fig.1c). Note also that the temporal expansion was larger for the critical IP juncture for Late Closure (i.e., after N2), compared to the optional IP one (i.e., after 'or'). In terms of glottalization, the presence of an IP boundary did not consistently induce glottalization. For the IP

juncture after [N1-and] in Phrasing Type 1, which exhibited the most robust temporal expansion, no boundary-related glottalization was observed (Fig. 1b). Conversely, the IP junctures after N2 (Phrasing Type 2) or 'or' (Phrasing Type 3) showed increased glottalization of the initial vowel at the IP-initial position compared to the IP-medial position (Fig. 1c-d).

The main findings of this study highlight a consistent mapping between syntax and prosody in syntactic disambiguation, as discussed in previous literature [e.g., 7]. Notably, our results reveal that glottalization is not always used to mark a higher prosodic (IP) juncture, despite the expected association between prosodic phrasing and prominence marking in Korean as an edge-prominence language [6]. Instead, glottalization appears to be utilized more for avoiding vowel hiatus within phrases, offsetting its use as a marker of higher prosodic junctures in some cases. On a related note, our findings indicate that the phonetics-prosody interface, representing the phonetic implementation of prosodic structure categorically defined by the intonational phonology of the language, is finely tuned by syntactic structural information. We observe varying degrees of glottalization and temporal expansion, possibly in a reverse direction. The robust temporal expansion of an early IP serves as a clear cue for critical syntactic junctures (Early Closure), while glottalization plays a minimal role in this context. However, glottalization becomes more prominent when the temporal cue is less robust. We propose that voice quality is modulated by system-driven factors, particularly the motor system, which considers the relative contributions of available suprasegmental and segmental cues in signaling prosodic structure.

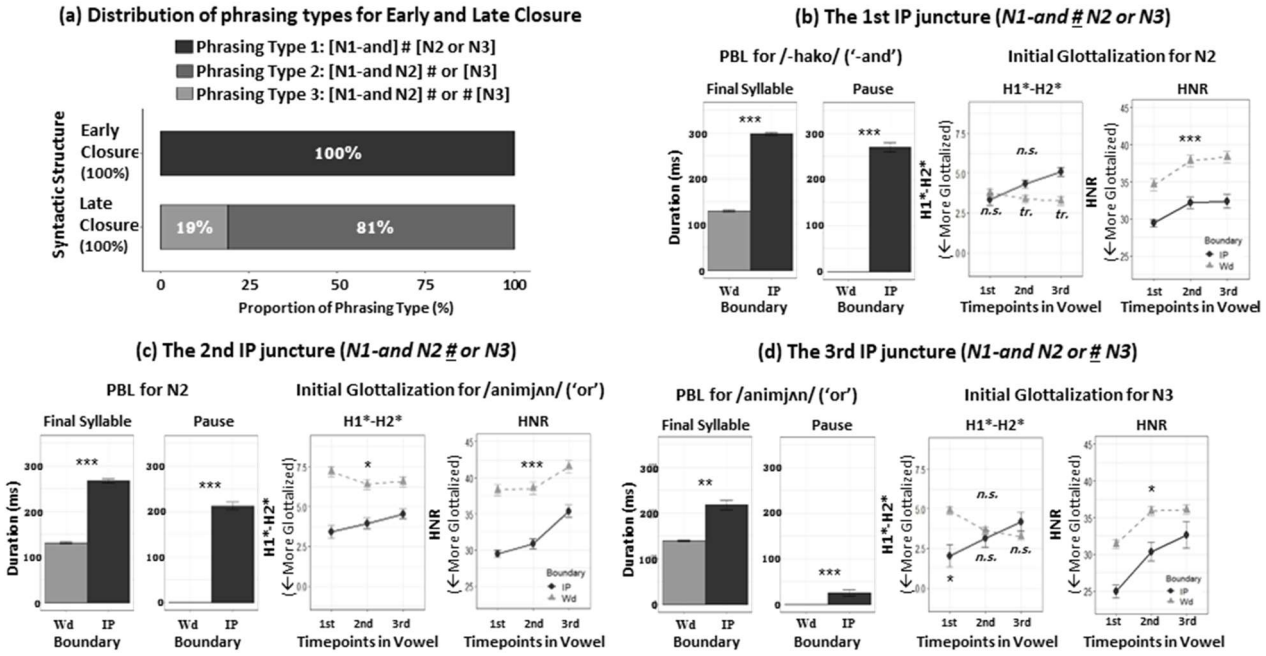

Fig. 1 Distribution of phrasing types for Early and Late Closure (a), and effects of boundary at the first (b), second (c), and third juncture (d) on final syllable and pause duration, and initial vowel's glottalization. *n.s.*, $p>0.1$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$. Error bars refer to standard errors.

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