Tonal alignment with articulatory gestures in South Kyungsang Korean

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Studies in Intonational Phonology have shown that tones (f_0 movements) are consistently aligned with segmental landmarks, known as *segmental anchoring* [1]. But they also showed that specific timing of tonal alignment with segments may differ across languages, especially depending on whether tonal pattern is determined lexically or post-lexically. Interestingly, several studies have examined this tone-segment alignment using Articulatory Phonology (AP), where not only segments but also tones can be considered as an articulatory gesture with an abstract target [2]. In AP, onset consonant and vowel gestures are generally known to have an in-phase coupling relationship. But the studies showed that the effect of tonal alignment on the timing of segmental gestures may differ depending on the intonational system of the language [3,4]. For instance, in some post-lexical pitch accent languages, Catalan and Viennese German, the alignment of H tone gesture in rising pitch accent does not adjust the timing of onset CV gestures, regardless of whether H tone is aligned with onset CV, simultaneously or sequentially [3]. In a lexical tone language, Mandarin Chinese, however, the alignment of H tone modifies the timing of onset CV gestures [4]. That is, in CV with H tone, onset C gesture is shifted leftward, and H tone gesture is shifted rightward, and in the middle of these two gestures, V gesture is aligned (i.e., like a C-center effect in English CCV).

Unlike these languages, South Kyungsang Korean (SKK) is a lexical pitch accent language, where tonal patterns of particular words are determined lexically (e.g., /pam/: H tone, *rice* vs. LH tone, *chestnut*), while the rest of the tonal pattern is defined post-lexically [5]. However, previous studies have only looked at tone-segment alignment patterns in the post-lexical pitch accent and the lexical tone languages, but not in the lexical pitch accent languages. Therefore, the present study will explore how a tone gesture for H and LH is aligned with segmental gestures in CVC and CVN in SKK. We will also examine how specific tonal alignment on segments differs depending on tonal type (H/LH) and coda type (CV<u>C</u>/CV<u>N</u>).

In the experiment, 11 SKK speakers in their 20's (6F, 5M) participated. Three monosyllabic target words varied in terms of lexical pitch accent (H vs. LH) and coda (obstruent, CVC vs. sonorant, CVN): /pap/ (H, *rice*), /pam/ (H, *night*), and /pam/ (LH, *chestnut*). They were included in the phrase-medial position of a carrier sentence and were provided a mini discourse situation where the target word is assigned a contrastive focus (Table 1). In the recording session, participants heard a pre-recorded question by a male SKK speaker through a loudspeaker and answered with a carrier sentence presented on a screen. A total of 660 sentences were recorded: 3 words x 20 repetitions x 11 speakers.

An Electromagnetic Articulography was used to measure oral constriction gestures (Lip Aperture for /p, m/, Tongue Body movement for /a/). Acoustic data were also obtained to measure tone gestures (f_0 movement). The ONSET and TARGET of constriction gestures were defined as a point of 20% of peak or trough in velocity profile. T-ONSET was at a point where f_0 initiates rising for H tone, and T-TARGET was at a point where f_0 reaches its peak (f_0 maximum).

Results showed that onset consonant and vowel gestures started simultaneously (Fig.1), in line with the notion of an in-phase relationship between onset CV gestures [2]. As for the VC timing, coda C gesture came sequentially after vowel gesture attained its target, showing a specific VC timing pattern in SKK in conjunction with the notion of an anti-phase coupling relationship between VC gestures [2]. Interestingly, H tone gesture showed an in-phase coupling relationship with coda C gesture, simultaneously showing an anti-phase coupling relationship with onset CV gestures. This shows that the effects of tonal alignment on segmental timing in SKK are different from a C-center like effect in Mandarin (lexical tone language) [4], but similar to those found in Catalan (post-lexical pitch accent language) [3], in a way that onset CV gestures remain in-phase coupled with each other, while H tone gesture is aligned much later after the CV gestures. Crucially, fine phonetic details of tone gesture in SKK differed depending on coda and tonal type. As for the coda type (Fig1.a-b), H tone gesture reached its target differently in CVC and CVN depending on coda's sonorancy. That is, the tonal target was attained much earlier in CVC than in CVN with respect to the coda's target. As for the tonal type (Fig1.b-c), H tone gesture was realized differently with a simplex

tone (H) vs. a complex tone (LH) in the same CVN contexts. H tone gesture started after vowel gesture, but it was shifted much to the right for LH than for H, both T-onset and T-target being timed much later relative to V-target in LH than in H. Also, H tone gesture was longer for LH than for H, in line with the expectation that a complex tone requires longer duration to realize its target compared to a simplex tone.

To conclude, our study showed that how a tone gesture is aligned with segmental gestures in a lexical pitch accent language, SKK, by comparing differences and similarities observed in the lexical tone and the post-lexical pitch accent languages. We also showed that fine-phonetic details of the tone-segment alignment differ depending on coda and tonal type. Further studies are needed to generalize these patterns to other languages.

Table 1. Test sentences. Target words are underlined, and the focused words (a contrastive focus) in the prompt sentences (Q) and the carrier sentences (A) are in bold.

Word	Tone	Meaning	Test sentences
/pap/	H	'rice'	Q: [jobʌn tanʌnɯn ʌnni**kuk**dwi-ɛ-da non-na]? *Do (I) put the word behind sister's **soup** this time?* A: [ani. ʌnni**pap**dwi-ɛ]. *No. Put (it) behind sister's **rice**.*
/pam/	H	'night'	Q: [jobʌn tanʌnɯn ʌnni**pam**dwi-ɛ-da non-na]? *Do (I) put the word behind sister's **chestnut** this time?* A: [ani. ʌnni**pam**dwi-ɛ]. *No. Put (it) behind sister's **night**.*
/pam/	LH	'chestnut'	Q: [jobʌn tanʌnɯn ʌnni**pam**dwi-ɛ-da non-na]? *Do (I) put the word behind sister's **night** this time?* A: [ani. ʌnni**pam**dwi-ɛ]. *No. Put (it) behind sister's **chestnut**.*

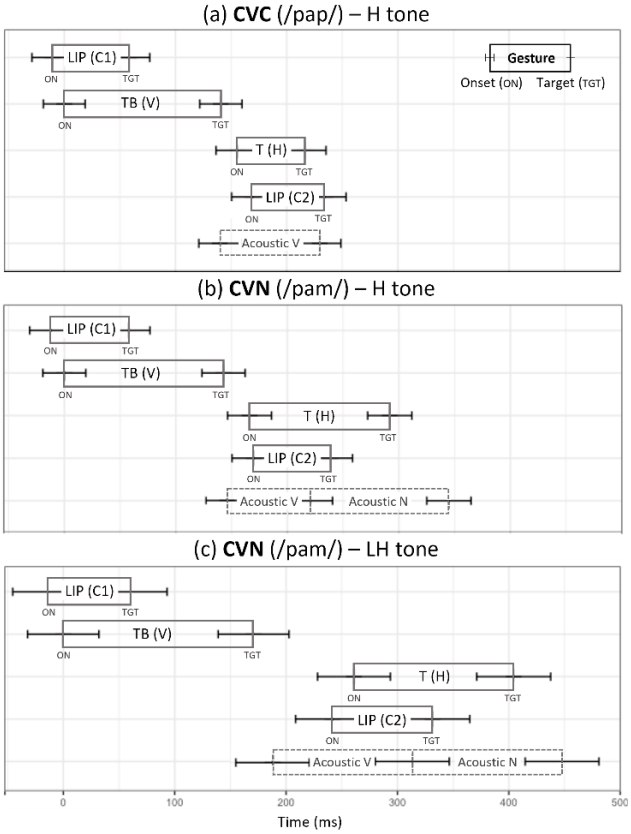

Fig1. Timings of C1-closing (Lip Aperture) gesture, V-gesture (Tongue Body lowering), C2-closing (Lip Aperture), and Tone (High, f_0 movement) gesture, depending on (a-b) coda type (CVC/CVN) and (b-c) tonal type (H/LH).

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