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Effects of syllable structure and prominence on the alignment and the scaling of the phrase-initial rising tone in Seoul Korean: A preliminary study

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ABSTRACT

The present study investigates the effects of syllable structure and prosodic prominence on the patterns of tonal alignment and scaling of the phrase-initial rise in Seoul Korean. Two syllable structures (Onset (/#CVC.../ as in *minsa*) vs. No-onset (/#VC.../ as in *insa*)) and two prominence conditions (Focus vs. Neutral) were considered. Results showed that the alignment of the L and the H tones in the phrase-initial rise was affected by syllable structure but not by prominence. The time of L was before the vowel onset of the first syllable in the Onset condition (i.e., within the onset consonant) and it was after the vowel onset in the No-onset condition. The difference was attributable to the fact that the initial L was anchored at a fixed distance from the phrase boundary, which was about 30ms after the onset of the syllable in both cases. The time of H was also consistently observed about 20ms after the second vowel onset (i.e., /a/ in *minsa/insa*). Moreover, the rise time (the duration from the L to the H tones) was longer as the local syllable duration became longer due to different syllable structure and prominence conditions. Taken together, the results provide a support for the segmental anchoring hypothesis, which claims that both the beginning and the end of F0 movement are consistently aligned with segmental 'anchor' points with relatively high stability (Ladd et al., 1999). Results also showed that the scaling of the early rise was slightly influenced by syllable structure but not by prominence. The differences between the results of the current study and a previous study (Cho, 2011) are further discussed.

Keywords: tonal alignment, tonal scaling, Seoul Korean, focus, syllable structure

1. Introduction

One of the important topics in the study of linguistic intonation is how F0 movements are temporally coordinated with segmental strings. While researchers have sought for answers to this question, the segmental anchoring hypothesis (henceforth, SAH) has become quite influential, claimed to be a potentially universal tendency (Ladd, Mennen & Schepman, 2000). The SAH claims that both the beginning and the end of F0 movement are consistently aligned with segmental 'anchor' points with relatively high stability, and this hypothesis indeed found supports from various languages (Arvaniti, Ladd & Mennen, 1998 for Greek; Atterer & Ladd 2004 for German; Ladd, Faulkner, Faulkner & Schepman, 1999 for English; Schepman, Lickley & Ladd, 2006 for Dutch; Xu, 1998 for Chinese).

The aforementioned studies employed a rate manipulation method, following Ladd et al. (1999), in order to test the validity of the SAH. The assumption of this method is that, if the F0 turning points are consistently aligned with specific segmental strings (i.e., anchors), the duration of F0 movement (e.g., the distance between the L and the H targets in a LH rising tone) should vary as the utterance duration changes due to speech rate manipulation (e.g., slow *vs.* normal *vs.* fast speech). If the SAH holds, the rise time between the L and the H in a rising tone, for example, will take longer as the speech is produced slower (i.e., with longer duration).

Adapting the same speech rate manipulation method, some

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studies have shown that the SAH is not fully supported in languages such as French or Korean. It is, in a way, interesting because the two languages only involve phrasal level intonation in their prosodic system (Jun & Fougeron, 2002; Jun, 2000), unlike Indo-European languages or Chinese where lexical unit prominence (such as lexical stress and lexical tone) plays a crucial role in the prosodic system. (As mentioned above, these latter types of languages have shown strong evidence for the SAH.)

Welby (2002), for instance, showed that in French, where the phrasal tone is usually modelled with the early and late rises within an Accentual Phrase (i.e., LHLH, see Jun & Fougeron, 2002), only two tones show some kind of anchoring. She found that the final H (in the late rise) in the AP was consistently realized near the end of the last syllable, and the initial L (in the early rise) was consistently anchored at the boundary between a function word and a content word. The other two tones (i.e., the first H and the second L in the LHLH pattern) did not provide any evidence of segmental anchoring. Welby and Lœvenbruck (2006) further observed speech rate effects on F0 scaling of the French late rise from a subset of their speakers, which does not go along with the assumption of the SAH that the speech rate would not have crucial effect on F0 excursion size (Ladd et al., 1999).

Likewise, Cho (2011) found that the alignment pattern of the Seoul Korean phrase-initial rising tone (i.e., the first LH in the LHLH pattern of the Accentul Phrase, see Jun (2000) for the description of Seoul Korean intonation) cannot be accounted for solely by the SAH. Investigating the tonal patterns of four-syllable APs (with a trisyllabic content word and a topic marker or a particle) in varying speech rate, she found general alignment patterns in the phrase-initial rising tone: The anchor for the L tone was the middle of the first rhyme, and the middle of the second rhyme was the anchor for the H tone. However, the location of H peaks found to vary relative to the anchor in different speech rates: the peaks were observed before the segmental anchor at slow speech rates and after it at fast speech rates. The initial L tone was also subject to change depending on the speech rate, such that the trough (F0 minium) for the L tone appeared earlier in the faster speech and later in the slower speech. The fact that the alignment of two tones vary as a function of speech rate suggests that the Korean alignment pattern is also affected by a constraint to maintain a constant duration between the two tonal targets. Based on these findings, she proposed the Alignment-Duration model, which takes both segmental alignment and target duration as weighted constraints.

Another way of manipulating the duration to test the tonal alignment, other than the rate manipulation approach, is to observe how the peaks vary across syllable structures. While the speech rate manipulation can be considered as a global duration change over an utterance, the syllable structure manipulation can be considered as a local duration change at a syllabic or a lexical level. Crucially, when syllable structure was manipulated (as in open *vs* closed syllables, where the latter is longer), the predictions of the SAH failed to be borne out in quite a few studies on Indo-European languages. In Neapolitan Italian, the tonal peak was located closer to the vowel offset in closed syllable than in open syllable (D'Imperio, 2000). A similar effect has also been found in a French late rise (i.e., the second LH in the LHLH pattern) (Welby & Lœvenbruck, 2006) and Spanish (Prieto & Torreira, 2007). The results of these studies suggest that different durational factors that may potentially influence tonal alignment might bring about inconsistent results, and therefore the factors must be considered separately in order to obtain a better understanding of how tonal alignment works.

While the effect of a global duration change on tonal alignment of Korean has been investigated (Cho, 2011), it has not yet been studied how a local duration change at a syllabic/lexical level may influence Korean tonal alignment and whether and how its effect is different from the global speech rate effect. In addition, despite the fact that prosodic prominence significantly modifies local duration and pitch range, the effect of prominence has not been considered in the studies that have tested the validity of the SAH. The current study attempts to fill these gaps by investigating how local duration variations due to syllable structure and prosodic prominence affect the tonal alignment and scaling of phrase-initial rise (LH) in Seoul Korean.

This study first compares two different syllable structures, CVC *vs*. VC phrase-initial syllables in five-syllable APs to observe whether and how two tonal targets in the early rise are differentially aligned with respect to vowels in the first two syllables with which they are associated. While Cho (2007) simply assumed that the initial L coincides with phrase onset, Cho (2011) showed that the L tone is anchored at 30% point in the first rhyme. The H tone was found to be anchored at the mid point of the rhyme in Cho (2011), as described earlier. In Cho (2011)'s study, however, syllable structures were balanced out and hence a potential effect of local duration change could not be observed. The present study attempts to see in detail how

the alignment patterns may vary depending on the syllable structure variation. In addition to the attempt to find the precise anchoring point for the two targets in each syllable structure, this study will also test whether the predictions of the SAH can be borne out by comparing the alignment patterns in the two syllable structures. Since the total duration of the syllable is longer for CVC than for VC (especially when the consonants are sonorants as possible tone-bearing segments), it can be hypothesized that the duration between the two targets (i.e., L and H) would be longer in CVC than in VC if the SAH is supported. In addition, since the SAH does not assume the influence of the segmental anchoring on the magnitude of the rise (Ladd et al., 1999), it can be hypothesized that the pitch value difference between the L and H targets would not be affected by syllable structure.

This study also examines whether and how the pattern of alignment may vary in focal vs. non-focal contexts by comparing target words with contrastive focus vs. no focus (in neutral reading). Unlike speech rate manipulation and syllable structure, the prominence factor has not been considered in the studies that have tested the SAH. However, if the SAH is adopted, it can be hypothesized that the rise time (i.e., the time between the L and the H tone) may be longer when the target words are focused, since the prominence also affects local duration. Furthermore, it will be interesting to examine whether and how tonal scaling is affected by local prominence. While the SAH does not have a theory-internal prediction about the change of tonal scaling as a function of prominence, previous studies on Korean have provided mixed results. Jun & Lee (1998), for example, claimed that extended pitch range marks focused words in Korean (see also Cho, Lee, & Kim, 2011 for similar results), but a recent study has not found significant contribution of pitch in phonetic realization of focus in Korean (Lee, Wang, Chen, Adda-Decker, Amelot, Nambu, & Liberman, 2015) contrary to other languages which make use of pitch as phonetic markers for focus realization.

2. Methods

2.1 Participants

Six (four female and two male) native speakers of Seoul Korean participated in the study. All of them were undergraduate students in their 20's. They were not aware of the purpose of the experiment and were paid for participation.

2.2 Speech material and procedures

A consonant initial syllable (#CVC) and a vowel initial syllable (#VC) were created for the Onset and the No-onset conditions, respectively. In the Onset condition, the consonant /m/ was inserted in the word-initial, syllable onset position (/#**min**.../ in a word *minsa*). In the No-onset condition, the target syllable started with a vowel (/#**in**.../ in a word *insa*). The prosodic boundary (#) before the target words was an Intonational Phrase boundary (IP). Vocative constructions were provided before the target words so that speakers could naturally produce an IP boundary in front of the target words. Following the Strict Layer Hypothesis (Selkirk, 1986) and a K-ToBI model for the Korean intonational structure (Jun, 2000), it was assumed that an Accentual Phrase is contained in an Intonational Phrase. The AP-initial rise is therefore naturally expected to occur in the IP-initial position. There were two prominence conditions, Focused and Neutral conditions. The post-boundary words were accented with a contrastive focus (Focused), or were produced without a prominence on a specific word in an utterance (Neutral). The focused words are underlined in bold in Table 1. The words italicized in bold are the contrasted words which always occurred before the target sequence. Before the recording, speakers were given enough time to understand the speech materials and notice different focus contexts. This was done in order to help them to produce appropriate focus types (i.e., contrastive focus vs. no focus).

Table 1. Test speech materials

Target		Target-bearing sentences
/#min/ (Onset)	F	[ja],[***insa***hweikaanira], [jʌŋmaniilnjnʌtʃʰa]$_{IP}$,#[**minsa**hweiɛatʃikankas*ni] 'Hey, I'm not talking about the personnel meeting; First-year Youngman, didn't you go to the civil affairs meeting yet?'
	N	[ja],[jʌŋmaniilnjnʌtʃʰa]$_{IP}$,#[minsahweiɛatʃikankas*ni] 'Hey, first-year Youngman, didn't you go to the civil affairs meeting yet?'
/#in/ (No-onset)	F	[ja],[***minsa***hweikaanira], [jʌŋmaniwaŋkotʃʰam]$_{IP}$,#[**insa**hweiɛatʃikankas*ni] 'Hey, I'm not talking about the civial affairs meeting; Senior Youngman, didn't you go to the personnel meeting yet?'
	N	[ja],[jʌŋmaniwaŋkotʃʰam]$_{IP}$,#[insahweiɛatʃikankas*ni] 'Hey, Senior Youngman, didn't you go to the personnal affairs meeting yet?'

Sentences were repeated four times in a random order. The data were collected in a sound attenuated room using a SHURE

KSN44 dynamic microphone and a Tascam HD-P2 digital recorder. The collected data was later checked by two K-ToBI transcribers to ensure that the sentences were produced with intended prosodic renditions. The total of 96 tokens (2 accent types x 2 syllable structures x 4 repetitions x 6 speakers) were included for the data analyses.

2.3 Measurements

To observe the alignment and scaling patterns, the L and H tones in the phrase-initial rise were determined by the local F0 minimum and the local F0 maximum within the first and the second syllables, respectively.

In order to observe the pattern of alignment for the L tone, the distance was measured from the onset of the first vowel (V1, /i/) in the target word to the time of local F0 minimum (henceforth V1-to-L distance). Similarly, for the H tone, the distance from the onset of the second vowel (V2, /a/) in the target word to the time of local F0 maximum was measured (henceforth V2-to-H distance). Note that the target words contained /s/ as the onset of the second syllable, which may cause local F0 perturbation. This influence from /s/ was ignored in determining the H peak. In addition, when there was a high plateau (instead of a clear F0 maximum), the inflection point (i.e., the beginning of the plauteau) was defined as the location of the H tone, as in Welby and Lœvenbruck (2006). (Note that there was only 2.6 Hz average pitch difference between the pitch value at the beginning of the high plateau and the highest F0 value within the plateau.) The standard deviations for these two measures (i.e., the V1-to-L distance and the V2-to-H distance) were also calculated in order to observe the stability of the tone with regard to each segmental landmark. In addition, the rise time (i.e., the duration between the L and the H targets) was calculated to observe the effect of local durational change on the rise time. The duration of segments, the rhyme duration and the total duration of the first syllable were also measured.

Finally, the pitch values for the F0 minimum (L) and the F0 maximum (H) were measured in order to see the influence of syllable structure and prominence on the tonal scaling.

2.4 Statistical Analyses

A series of repeated measures analyses of variance (RM ANOVAs) were conducted for statistical evaluation of the influence of the syllable structure and the prominence on the tonal alignment and scaling. Syllable Structure (Onset vs. No-onset) and Prominence (Focused vs. Neutral) were two within-subject factors. When there were interaction effects between factors, posthoc pairwise comparisons were conducted. P-values less than 0.05 were considered significant, and those between 0.051 and 0.8 were considered as trend effects.

3. Results

3.1 Effects of syllable structure and prominence on tonal alignment

The distance between the onset of V1 (/i/ in /minsa/ or /insa/) and the phrase-initial L tone (i.e., V1-to-L distance) was significantly influenced by Syllable Structure ($F[1,5]=90.97$, $p<.001$). In the Onset condition (/minsa/), the location of the L target was earlier than the V1 onset (mean= 16.7ms). In the No-onset condition (/insa/), the L tone was realized after the V1 onset (mean= -29.2ms) (compare the locus of the L tone in Figure 1a and 1b). The presence of prominence did not influence the L tone alignment, and there was no significant interaction between Syllable Structure and Prominence.

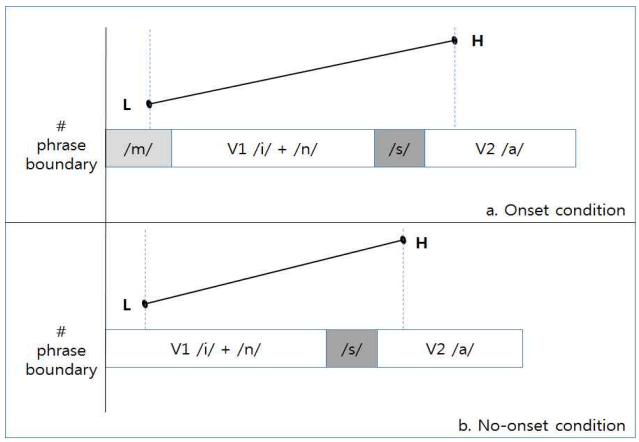

Figure 1. Location of the L and the H targets with respect to segmental landmarks (The upper panel (a) shows the tonal alignment for the Onset condition, and the lower panel (b) the No-onset condition. Note that average durations for each segment are illustrated by the length of boxes in the bars. The two bars are aligned at the beginning of a phrase as indicated by a vertical line. Since scaling difference was only 6 Hz in the Onset vs No-onset conditions, the F0 slope in both panels was assumed to be identical for the illustrative purpose.)

The distance between the V2 onset (/a/ in /minsa/ or /insa/) and the H tone (i.e., V2-to-H distance) in the Korean phrase-initial rise also showed the effect of Syllable Structure ($F[1,5]=7.06$, $p<.05$). Although the H tone appeared after the V2

onset in both cases, the time of H was later (i.e., farther from the V2 onset) in the Onset condition (mean= -22.7ms) than in the No-onset condition (mean= -18.6ms) (compare the locus of H in Figure 1a and 1b). There was no significant effect of Prominence, nor was there an interaction between the two factors.

The standard deviation for V1-to-L showed no effect of Syllable Structure and Prominence. The standard deviation values for V2-to-H, however, showed a significant effect of Focus ($F[1,5]=8.78$, $p<.05$). When focused, the standard deviation was 8.7ms on average, while it was 5.6ms on average in the Neutral condition, suggesting that V2-to-H distance was more unstable when the target words were focused.

Note that both the total duration and the rhyme duration of the first syllable showed a significant effect of Syllable Structure. The total syllable duration was longer for the Onset condition than for the No-onset condition ($F[1,5]=60.7$, $p<.001$, mean difference = 36.2ms), most likely due to the presence of the initial consonant /m/. The rhyme duration, however, was longer for the No-onset condition than the Onset condition ($F[1,5]=14.97$, $p<.05$, mean difference = 13.8ms), possibly due to the compensatory lengthening in order to achieve a constant syllable (or word) duration. While focus did not influence the alignment of the L and the H in the initial rise, the first syllable duration was significantly longer ($F[1,5]=8.26$, $p<.05$) and the rhyme duration tended to be longer ($F[1,5]=4.98$, $p=.076$) in the Focus than in the Neutral conditions. The effect of Prominence on the duration measures did not further interact with the Syllable Structure factor.

As for the rise time (i.e, the duration between the time of L and that of H), significant effects of Syllable Structure and Prominence were found ($F[1,5]=9.43$, $p<.05$; $F[1,5]=13.92$, $p<.05$, respectively), and there was a significant interaction between the two factors ($F[1,5]=22.06$, $p<.01$). In general, the rise time was longer in conditions where the segments are lengthened: it was longer in the Onset than in the No-onset conditions, and in the Focus than in the Neutral conditions. The interaction, however, showed that the Prominence effect was significant only in the Onset condition ($t(5)=5.93$, $p<.01$; ave. difference: Focus 283.9 *vs* Neutral 240.8 ms) and that the Syllable Structure effect was significant only in the Focus condition ($t(5)=4.59$, $p<.01$; ave. difference Onset 283.9 *vs* No-onset 245.1 ms).

3.2 Effects of syllable structure and prominence on tonal scaling

Results showed that the pitch difference between the L and H tones was significantly affected by Syllable Structure. The difference was larger in the Onset condition than in the No-onset condition ($F[1,5]=11.3$, $p<.05$) and the numeric difference was 6.1Hz. This effect is mostly due to the fact that the F0 minimum is lower for the consonant /m/ in the Onset condition (177.3Hz) than for the vowel /i/ in the No-onset condition (181.8Hz). The Prominence effect, however, did not have any effect on the magnitude of rise (tonal scaling) in Korean.

4. Discussion

This study investigated the effect of local duration change on the tonal alignment and scaling of phrase-initial rise in Seoul Korean. Two factors, syllable structure and prominence, that could bring about durational change and hence potentially influence the tonal alignment and scaling, were considered.

The distance between the first vowel onset and the time of L significantly changed due to syllable structure. The L tone was realized 16.7ms before the vowel in average (which was about 33.3ms after the consonant onset) in the Onset condition, and it was realized 29.2ms after the vowel in average in the No-onset condition. These showed that there is rather a consistent anchor for the initial L tone, which is about 30ms (more or less) after the beginning of the first post-boundary segment, regardless of syllable structure. The distance between the second vowel onset to the time of H was also significantly affected by the syllable structure: that is, the time of H was later in the Onset than in the No-onset condition. The difference between the two alignment points was, however, only 4.1ms (22.7 vs 18.6ms), and what is important is that they both occurred consistently after the onset of V2. Based on the current results, it would not be too far-fetching to estimate that the L in the phrase-initial rise is anchored about 30ms after the boundary, and the H is anchored about 20ms after the V2 onset (although these numerical values are only indicative as they are subject to further modification due to various factors). In addition, these anchoring patterns were not affected by focus, indicating that the segmental anchoring was consistent regardless of prominence. Moreover, the analyses on the standard deviation of the anchoring points suggest that the L anchoring was in general quite stable, while the H was rather unstable especially when the target words were focused. This pattern seems to be in line with the previous finding that H peaks tend to deviate much

more than L troughs in general (Cho, 2011; Prieto & Torreira, 2007).

Another interesting finding of this study is that the rise time (from the time of L to that of H) was affected by both the syllable structure and the prominence factors. To be specific, the rise time was longer when significant local lengthening was observed (due to the addition of a segment (i.e., in the Onset condition) and to the focus-induced lengthening). This indeed follows from the prediction of the SAH as explained in the introduction. Taken together, the relatively consistent anchoring patterns and the rise time variation as a function of local lengthening seem to strongly support the SAH.

Note that the patterns of anchoring reported here are quite different from those found in Cho (2011) which showed that both the L and the H tones are anchored much later in the rhyme (The L tone is anchored in the middle of the first rhyme and the H tone in the middle of the second rhyme), and that constant duration also plays a role in the alignment of Korean phrase-initial rise. One of the possible explanations for the difference between the present study and Cho's is that various syllable structures were included in Cho (2011)'s data, while syllable structure was one of the experimental factors in the current study. The difference may also have stemmed from the fact that Cho (2011) manipulated speech rate and the current study did not. As mentioned earlier, it seems that the global duration change (achieved by the speech rate manipulation) and the local change (obtained by the syllable structure manipulation) may influence tone alignment differently. At this point, the resolutions should be left for future studies.

Finally, the current study showed a significant effect of syllable structure, but no effect of prominence on the tonal scaling of the phrase-initial rise in Seoul Korean. While the change of the magnitude of the rise (tonal scaling) due to syllable structure differences may be interpreted as working against the SAH which does not expect the magnitude change to occur, this approach should be taken with caution for two reasons. First, the difference in the magnitude of F0 rise might have been due to the different nature of consonants and vowels (recall that the F0 minimum was realized within the onset consonant for the Onset condition but within the initial vowel for the No-onset condition). Second, the numeric difference was not too big (about 6 Hz) which may not have much linguistic function.

It is also worth pointing out that the null effect of focus on the tonal scaling is consistent with Lee et al. (2015) but in contrast with findings reported in Cho et al. (2011) and Jun & Lee (1998). While there is no clear explanation to offer regarding the mixed results, it appears that Korean does not seem to employ tonal scaling as a consistent phonetic marker of focus realization.

In conclusion, the present study demonstrated that anchoring points for the L and the H in phrase-initial rise in Korean are by and large fixed relative to the segmental points, which are further influenced by syllable structure. These results are interpretable in terms of the segmental anchoring hypothesis, suggesting that the relative timing of tonal realization is not randomly realized independent of segmental structure, but that there is an intricate linkage between segmental and suprasgemetal events that appear to be modulated by a higher-order prosodic structure. It is hoped that the results of this small-scaled, preliminary study serve as the basis for further studies which illuminate the exact nature of the tone-segment alignment pattern in Korean in connection with higher-order linguistic structure.

References

Arvaniti, A., Ladd, D. R. & Mennen, I. (1998). Stability of tonal alignment: The case of Greek prenuclear accents. Journal of Phonetics 26, 3-25.

Atterer, M. & Ladd, D. R. (2004). On the phonetics and phonology of 'segmental anchoring' of F0: Evidence from German. *Journal of Phonetics* 32, 177-197.

Cho, H. (2007). The effects of speech rate on segmental anchoring. Unpublished ms. MIT.

Cho, H. (2011). The timing of phrase-initial tones in Seoul Korean: a weighted-constraint model. *Phonology* Vol.28, No.3, 293-330.

Cho, T., Lee, Y., & Kim, S. (2011). Communicatively driven versus prosodically driven hyper-articulation in Korean. *Journal of Phonetics* 29, 344-361.

D'Imperio, M. (2000). The role of perception in defining tonal targets and their alignment. Unpublished doctoral dissertation. The Ohio State University.

Jun, S.-A. (2000). K-ToBI Labelling Conventions. http://www.linguistics.ucla.edu/people/jun/ktobi/k-tobi.html

Jun, S.-A. & Fougeron, C. (2002). A phonological model of French intonation. In B. Antonis (ed.), *Intonation: Analysis, Modelling and Technology*. Boston: Kluwer. 209-242.

Jun, S.-A. & Lee, H-J. (1998). Phonetic and phonological markers of contrastive focus in Korean. In *Proceedings of the 5th International Conference on Spoken Language Processing* 4,

1295-1298.

Ladd, D. R., Faulkner, D., Faulkner, H. & Schepman, A. (1999). Constant 'segmental anchoring' of F- movements under changes in speech rate. *Journal of the Acoustical Society of America* 127, 862-873.

Ladd, D. R., Mennen, I. & Schepman, A. (2000). Phonological conditioning of peak alignment in rising pitch accents in Dutch. *Journal of the Acoustical Society of America* 107, 2685-2695.

Lee, Y., Wang, B., Chen, S., Adda-Decker, M., Amelot, A., Nambu, S., & Liberman, M. (2015). A crosslinguistic study of prosodic focus. Poster be presented at the the 40th IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP).

Prieto, P. & Torreira, F. (2007). The segmental anchoring hypothesis revisited: syllable structure and speech rate effects on peak timing in Spanish. *Journal of Phonetics* 35, 473-500.

Schepman, A., Lickly, R. & Ladd, D. R. (2006). Effects of vowel length and 'right context' on the alignment of Dutch nuclear accents. *Journal of Phonetics* 34, 1-28.

Selkirk, E. (1986). On derived domains in sentence phonology. *Phonology* Vol.3, 371-405.

Welby, P. (2002). The realization of early and late rises in French: A production study. *Speech Prosody* 2002, Aix-en-Provence. 695-698.

Welby, P. & Lœvenbruck, H. (2006) Anchored down in Anchorage: syllable structure, rate, and segmental anchornig in French. *Italian Journal of Linguistics* 18, 73-124.

Xu, Y. (1998). Consistency of tone-syllable alignment across different syllable structures and speaking rates. *Phonetica* 55, 179-203.

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