DURATIONAL EFFECTS OF STRESS, ACCENT, AND VOICING ON THE PRECEDING WORD-FINAL SYLLABLE IN ENGLISH

Jiseung Kim[a], *Sahyang Kim*[b] & *Taehong Cho*[a]

[a]Hanyang University, Korea; [b]Hongik University, Korea
jiseungkim@gmail.com; sahyang@hongik.ac.kr; tcho@hanyang.ac.kr

ABSTRACT

This study examined how duration of an unstressed final syllable in English is affected by conditions in the following word: stress (trochaic/iambic), accent (accented/unaccented), and initial stop voicing (voiced/voiceless). Results showed that the unstressed final syllable was shorter before an unstressed syllable, presumably due to polysyllabic shortening—i.e., the following unstressed syllable forms a foot with the preceding syllable. This effect, however, disappeared when the following word was accented, due to foot restructuring caused by leftward spreading of accent effect—i.e., because the (following) unstressed syllable is lengthened when accented, it is no longer weak enough to be associated with the preceding foot. The lengthening of the word-final syllable before a voiced stop was also observed, but only within a foot. Most of the foot restructuring effects disappeared across an IP boundary. Interestingly, however, even across an IP boundary, the final syllable was affected by accentuation of the following word (i.e., shortened before an accented word), implying that the prominence structure may have a more global effect.

Keywords: stress, accent, voicing, duration, foot, word boundary, IP boundary, English

1. INTRODUCTION

Phonetic realization of segments is often influenced by prominence factors such as lexical stress and phrasal accent [1, 8, 9]. The prominence is generally localized to a lexically stressed syllable in English, and the effect may spread to neighboring syllables, extending over domains larger than the syllable, especially within a word [3]. But our knowledge has been quite limited with respect to the extent to which the prominence could influence neighboring syllables beyond a Word boundary. In the present study we address this question by investigating whether, and how, the temporal organization of the word-final syllable is conditioned by prominence factors associated with the following word. Combined with this, we also included a consonant voicing factor (voiced vs. voiceless) in order to examine the extent to which the voicing-induced lengthening, which has often been observed within a syllable, is manifested in the preceding syllable across a Word boundary, and how the effect is further modulated by the stress pattern of the following word. Several specific research questions and hypotheses are considered as outlined below.

The first specific question is whether the duration of the word-final unstressed syllable /nə/ in *banána* is modified by the lexical stress pattern of the following word (e.g., bánner vs. banál) across a Word boundary within a phrase, and if so, how. The influence of stress on the preceding unstressed syllable can be considered in terms of the foot structure [9, 10, 12] as given in (1):

(1) a. *ba**{nánə}**#{bánner}* b. *ba**{nánə#ba}**{nál..}*

The word-final /nə/ can be the final syllable of a disyllabic foot {nána} (1a) or the middle syllable of a trisyllabic foot {nánə#ba} (1b), depending on the stress pattern of the following word. The word-final /nə/ is then hypothesized to be longer in {nána} than in {nánə#ba} for two inter-related reasons—i.e., foot-level final lengthening in {nána} and/or polysyllabic shortening in {nánə#ba} [9].

Most importantly, however, being different from previous studies [9, 10], we test this hypothesis in conjunction with accentuation expressed by narrow focus—i.e., the following context word is accented or unaccented. So our second specific question is how the effect of lexical stress on the preceding word-final syllable interacts with accentuation of the context word. If the locus of accentuation is strictly localized to a stressed syllable, the accent factor is not expected to influence the foot structure, maintaining the prominence distribution as in (1).

In such a case, the stress-sensitive durational difference would not be affected by the

accentuation of the context word. Alternatively, however, given the possibility that accent-induced strengthening may spread leftward to the unstressed syllable in the iambic case (e.g., banál) (as discussed in [4, 5, 11]), some degree of prominence might fall on the initial unstressed syllable when the word is accented. This may result in foot restructuring, so that 'ba' in *banál* forms a phonetically prominent monosyllabic foot or some kind of 'extrametricality' as in (2b), which will effectively make a disyllabic foot of {nána} in both cases (2a-b), hence no durational difference.

(2) a. **{nánа}**#{bánner} b. **{nánа}**#<**ba**>{nál…}

Our third specific question concerns the durational effect of the voicing contrast of the consonant on the preceding word-final syllable. Again, the voicing effect can be considered in terms of foot structure: When the consonant belongs to the same foot with the preceding syllable (e.g., {nána#ba}), they may become more cohesive, with an increased likelihood of voicing-induced lengthening, while the effect may become weaker when they belong to different feet (e.g., **{nánа}**#{bánner}).

So far, we have discussed hypothesized effects of stress, accent and voicing that are associated with the following word across a phrase-internal Word boundary. While testing these effects in the word-boundary condition is the primary goal of the present study, we also included an IP-boundary condition to examine the extent to which their effects could be observed when the influence comes from the context word across a phrase boundary. Although the above-discussed assumptions based on differential foot structuring become irrelevant when an IP boundary intervenes between the test syllable and the context word, this will still allow us to test how globally the prominence structure of the context word may influence temporal organization of the preceding syllable across a major phrase boundary.

2. METHOD

2.1. Subjects and recording

Eleven native speakers of American English (6 female, 5 male) were paid to participate in the experiment. The recording was conducted in a sound-attenuated booth at the Hanyang Phonetics and Psycholinguistics Lab, using a SHURE KSN 44 dynamic microphone and a Tascam HD-P2 digital recorder at a sampling rate of 44 kHz.

2.2. Test materials and measurements

The word-final syllable was always an unstressed /nə/ in 'banana', so that it allowed least confounding effects that may arise with prominence on the test syllable. The following context words were all disyllabic, varying with lexical stress and the voicing of the initial stop (/b,d/ vs. /p,t/) as in Table 1. The two-word sequences were produced in the sentences as in Table 2. The context word was either accented (with a contrastive focus) or unaccented. For each condition in Table 2, the second sentence was always the target-bearing test sentence while the first sentence was used to induce the intended rendition. In order to induce a contrastive focus on the target words, both the target words in the test sentence and the corresponding words in the first sentence were all printed in bold. Speakers were then asked to read two sets of sentences with the meaning contrast in mind. The test sentences had either an IP boundary or a Word boundary that divided the two words in the test word sequences.

Table 1: The context words that vary with stress and voicing.

Stress Pattern	Bilabial initial		Alveolar initial	
	Voiced	Voiceless	Voiced	Voiceless
Trochaic	*bánner*	*pánel*	*Dániel*	*tánner*
Iambic	*banál*	*panáche*	*Denése*	*Tenése*

Table 2: Sample test sentences with the context word 'panel'.

1) IP boundary, Accented
After **I** say 'banana', '**BANNER** again' will be the next phrase to say. But after **JOHN** says 'banana', '**PANEL** again' will be the next phrase to say.
2) IP boundary, Unaccented
After **I** say 'banana', 'panel again' will be the **NEXT** phrase to say. But after **JOHN** says 'banana', 'panel again' will be the **FINAL** phrase to say.
3) Word boundary, Accented
To say 'banana **BANNER** again' with me is going to be difficult. But to say 'banana **PANEL** again' with me is going to be easy.
4) Word boundary, Unaccented
To say 'banana panel again' with **JOHN** is going to be difficult. But to say 'banana panel again' with **ME** is going to be easy.

We measured the duration of the word-final syllable /nə/ of 'banana' and the closure duration for the initial consonant of the following word. The closure duration was included to determine whether the leftward spreading of accent-induced strengthening is reflected in the closure duration of the unstressed syllable in the iambic context words (e.g., *banál*, *panáche*) and to what extent the temporal modification of the word-final syllable can be accounted for by the relationship between the syllable duration and the following closure

duration. Note, however, that the closure duration included the pause in the IP-boundary condition because the pause and the closure could not be separated in the acoustic signal. Thus a caution is needed in interpreting the data containing the closure duration at the IP boundary.

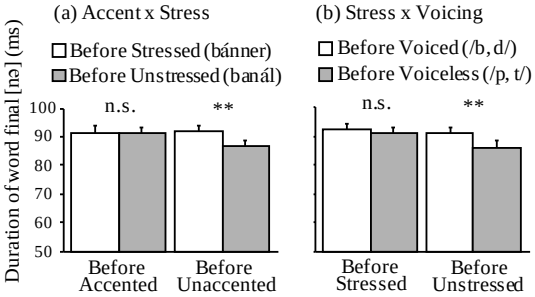
Three-way repeated measures Analysis of Variance (RM ANOVAs) were carried out, separately for the Word-boundary and the IP-boundary condition. The three factors were Accent (accented vs. unaccented), Stress (stressed vs. unstressed), and Voicing (voiced vs. voiceless). When necessary, a series of one-way ANOVAs was conducted as post-hoc and/or planned pair-wise comparison tests between levels.

3. RESULTS AND DISCUSSION

3.1. Effects of stress and accent

Results showed trend effects of Stress (F[1,10]=4.4, p=.06) on the preceding word-final syllable, while no Accent effect was observed. Crucially, there was a trend effect of Accent by Stress interaction (F[1,10]=4.2, p=.07) due to the fact that the word-final syllable was affected by the stress pattern of the following syllable: It was longer before a stressed than an unstressed syllable (p<.01) only when the context word was 'unaccented' (Fig. 1a). It appears that when the word-final unstressed syllable is grouped with the following unstressed syllable to form a foot (e.g., ba**{nánaba}**nál), its duration becomes shorter presumably due to a foot-level polysyllabic shortening. But the effect disappeared when the context word was 'accented'. Even when the unstressed word-final 'na' is in principle supposed to form a foot with the following unstressed syllable (e.g., ba**{nánaba}**nál), it did not show shortening when the following word 'banál' received accent (Fig.1a). This lack of shortening is in line with the hypothesis that when the leftward spreading of accent-induced strengthening to the initial unstressed syllable ('ba' in 'banál') is robust enough, it may create some degree of prominence of the unstressed syllable, resulting in modification of the foot structure as illustrated in {..ba}**{nána}**#<**ba**>{nál..}. In this case, 'ba' may be considered to be phonetically prominent forming a quasi-monosyllabic foot or becoming 'extrametrical', associated with neither the preceding nor the following foot. As a result, comparable foot structures are created—i.e., {..ba}**{nána}**{bánner} vs. {..ba}{**nána**} <ba>{nál}, which may account for the lack of shortening effect.

Figure 1: Duration (ms) of the word final [nə] in *banána* before a Word boundary.



Closure duration of the following consonant also showed a significant Accent by Stress interaction effect (F[1,10]=50.1, p<.001), supporting the foot restructuring hypothesis. It was longer in the accented than in the unaccented condition regardless of whether the initial syllable was stressed or not (both at p<.001). This again suggests that there was a robust leftward spreading of the accentuation effect, making the unstressed 'ba' at least phonetically prominent.

3.2. Effects of voicing and its interaction with stress

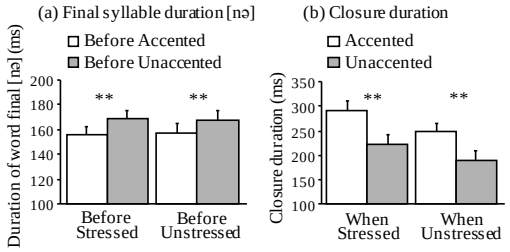
There was a trend of Voicing (F[1,10]=4.2, p=.067) and a trend interaction effect between Stress and Voicing (F[1,10]=4.4, p=.063). Planned pair-wise comparisons revealed that the voicing effect was modulated by stress—i.e., the word-final syllable was longer before a voiced than a voiceless stop only when the stop occurred in the unstressed syllable (p<.05). This asymmetry can also be understood in terms of differential foot structures of the two-word sequence. Again, when the following syllable is unstressed, it is likely to form a foot with the two preceding syllables (e.g., {nánaba}{nál..}), so that the voicing of 'ba' effectively influences the preceding syllable duration with more cohesiveness between the two, whereas no such effect arises when the voiced consonant is separated by the foot boundary (e.g., {nána}#{bánner}).

Closure duration of the following consonant also showed a significant Stress x Voicing interaction (F[1,10]=24.8, p=.001). In particular, in the unstressed condition where the voicing effect was observed, the closure duration did not differ between the voiced and the voiceless stop (p>.1), indicating that the lengthening before a voiced stop in the unstressed condition was not attributable to variation of the closure duration of the stop, but it rather operated at a more abstract foot structure level.

3.3. Effects of stress, accent and voicing across an IP boundary

In the IP-boundary condition, only the Accent factor generated a significant effect on the preceding word-final syllable ($F[1,10]=25.7$, $p<.001$). Importantly, the Accent effect did not interact with Stress (nor with Voicing), indicating that the word-final syllable is significantly shorter when the following context word is accented than when it is unaccented, irrespective of whether its initial syllable is lexically stressed (trochaic) or unstressed (iambic) (Fig.2a). This suggests that the differential foot structuring hypothesis associated with different prominence distribution is no longer valid across an IP boundary—i.e., the following stress pattern did not influence the duration of the preceding syllable.

Figure 2: Duration (ms) of the word final [nə] in *banána* (a) and closure duration of the following stop (b) across an IP boundary.



However, it is still interesting that the preceding syllable duration is not entirely independent from the prominence pattern of the following context word even across a major prosodic boundary. The word-final syllable duration was significantly shorter before the accented than the unaccented context word. A question then arises why the accentuation of the phrase-initial word gives rise to shortening of the preceding syllable across a phrase boundary. One possible explanation is that the vocalic gesture of the preceding unstressed syllable may be 'truncated' by a strong consonantal gesture that may arise with prosodic strengthening [2, 6, 7]. The consonant of the following syllable undergoes both domain-initial strengthening at an IP boundary and prominence-induced strengthening. The strong consonant gesture may come earlier (or get activated earlier) before the end of the preceding vocalic gesture, resulting in shortening the syllable. This interpretation, of course, is subject to further corroboration, but what remains true is that speakers shortened the preceding syllable before the accented context word, which may have a perceptual consequence of emphasizing the following accented word by maximizing the durational contrast between the two.

The closure duration of the following stop showed prominence-induced strengthening—i.e., it was longer when stressed and accented (Stress, $F[1,10]=11.0$, $p<.01$; Accent, $F[1,10]=26.3$, $p<.001$), but with no Accent by Stress interaction. That is, the accent effect held regardless of whether the stop-bearing syllable was lexically stressed or not (Fig.2b). This independently supports the leftward spreading of accent-induced strengthening in the IP-boundary condition as was in the Word boundary condition.

4. CONCLUSION

We found evidence that the final target syllable is subject to effects of stress, accent, and voicing contrast of the following context word across a Word boundary. The preceding final syllable which was shorter before an initially unstressed word was exempt from the shortening when the following word was accented. The results also showed that the voicing of the following stop, when unstressed, lengthened the final syllable duration. These results could be explained by variable foot structuring as a function of stress and accent interaction. The accent factor was also shown to truncate the preceding syllable even across a larger, IP boundary, showing its global effect.

5. REFERENCES

[1] Beckman, M.E. 1986. *Stress and Non-Stress Accent*. Berlin: Walter de Gruyter.

[2] Beckman, M.E., Edwards, J., Fletcher, J. 1992. Prosodic structure and tempo in a sonority model of articulatory dynamics. In Docherty, G.J., Ladd, D.R. (eds.), *Papers in Laboratory Phonology II: Segment, Gesture, Prosody*. Cambridge University Press, 68-86.

[3] Cambier-Langeveld, T., Turk, A. 1999. A cross-linguistic study of accentual lengthening: Dutch vs. English. *Journal of Phonetics* 27, 255-280.

[4] Cho, T., Keating, P. 2009. Effects of initial position versus prominence in English. *Journal of Phonetics* 37(4), 466-485.

[5] Cho, T., McQueen, J. 2005. Prosodic influences on consonantal production in Dutch: Effects of prosodic boundaries, phrasal accent and lexical stress. *JP* 33(2), 121-157.

[6] Edwards, J.E., Beckman, M.E., Fletcher, J. 1991. The articulatory kinematics of final lengthening. *JASA* 89, 369-382.

[7] Harrington, J., Fletcher, J., Roberts, C. 1995. Coarticulation and the accented/unaccented distinction: Evidence from jaw movement data. *JP* 23, 305-322.

[8] de Jong, K.J. 1995. The Supraglottal articulation of prominence in English: linguistic stress as localized hyperarticulation. *JASA* 97, 491-504.

[9] Lehiste, I. 1970. *Suprasegmentals*. Cambridge, MA: MIT Press.

[10] Port, R.F. 1981. Linguistic timing factors in combination. *JASA* 69, 262-274.

[11] Turk, A.E., Sawusch, J. 1997. The domain of accentual lengthening in English. *JP* 25, 25-41.

[12] White, L.S. 2002. *English Speech Timing: A Domain and Locus Approach*. PhD dissertation, University of Edinburgh.