The phonetics and phonology of onset-sensitive accentuation of novel words in North Kyungsang Korean*

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Kim, Hyun-ju. 2011. The phonetics and phonology of onset-sensitive accentuation of novel words in North Kyungsang Korean. *Studies in Phonetics, Phonology and Morphology* 17.2, 193-214. Aspirated onset consonants are not necessarily associated with a high tone pitch accent in North Kyungsang Korean although vowels following aspirated obstruent consonants tend to have higher F0 than those following other consonants in both standard Korean and Kyungsang dialects. However, this study presents evidence that aspiration plays a role in the assignment of a pitch accent pattern to novel words. This study shows that NKK accentuation of new words is not random but rather constrained: either by phonetics-based or phonologically-grounded constraints. This study suggests that even though the effect of aspiration on accentuation is not categorical, the phonetic effect was important enough to at least serve as a factor in deriving variation in accent patterns in newly adopted words. **(State University of New York at Stony Brook)**

Keywords: pitch accent, aspiration, F0, novel words, phonetic factor, variation

1. Introduction

North Kyungsang Korean (NKK), unlike standard Korean, is a pitch accent language in which accent is not fully predictable, as illustrated in the following minimal triple *káci* 'kind', *kací* 'eggplant', *kácí* 'branch'. Although syllable structure does not categorically predict accent placement in North Kyungsang Korean, a previous study of accent placement in novel words (H-J. Kim, in press) showed that NKK speakers' accenting of newly adopted words is not random, but rather is partially determined by the syllable structure of the words. Furthermore, the accent patterns were consistent with the statistical patterning in the lexicon, in which heavy syllables tend to be accented. In the absence of heavy syllables, penultimate accent was the most frequent in the lexicon and was also the preferred pattern in novel words. More than 80% of words which consist of all light syllables were assigned penultimate accent: 81% (88/108) of novel words and 82% (138/168) of existing trisyllabic words with no heavy syllables carried penultimate accent.

The current study explores phonetic factors that influence NKK accentuation in novel words and presents empirical evidence that

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aspiration plays a role in the assignment of a pitch accent pattern to novel words having no underlying accent information. Non-penultimate accent, which was rarely given in a word without aspirated consonants, was chosen when a word contains aspirated onsets. Double accent was more common in trisyllabic words whose initial syllable has aspirated onsets and final accent was assigned more often in bisyllabic words with aspiration on final onsets. These results suggest that NKK accentuation of new words is constrained either by phonetics-based or phonologically-grounded constraints. Therefore, although penultimate accent is dominant in NKK accentuation due to constraints which identify the penult as a default position, non-penultimate accent is also present as a variant by speakers who are more sensitive to the association between aspiration and higher F0 in accentuation of new words.

The rest of the paper is organized as follows: Section 2 presents linguistic background about phonetic effects of aspiration on adjacent vowels and lexical accent patterns in NKK. Section 3 presents an experimental study to examine phonetic effects on NKK accentuation in novel words. It was tested whether aspiration on onsets would influence accentuation of novel words. Section 4 discusses phonetic characteristics of accent patterns induced by aspiration. Section 5 discusses the results and Section 6 concludes.

2. Linguistic background

2.1 Phonetic effects of aspiration on adjacent vowels in Korean

The association of aspiration on obstruent consonants with fundamental frequency (F0) of the following vowel in Korean has been well known by many studies (Han & Weitzman 1970; Silva 1992, 2006; M-R. Kim 2000; M-R. Kim and Duanmu 2004; and many other studies). F0 was realized significantly higher after aspirated consonants than after lax consonants in Jeonnam Korean and Seoul Korean, which are not pitch accent languages (M-R. Kim and Duanmu 2004; Silva 2006). F0 has been assumed to be a redundant feature for the laryngeal contrast among lax, tense and aspirated stops in Korean, whereas voice onset time (VOT) has been assumed to be a robust phonetic cue for the phonation type contrast in that VOT is shortest for Korean tense stops (6-18ms), longer for lax (20-60ms), and longest for aspirated (100-115ms) (Lisker & Abramson 1964; C-W. Kim 1965; Silva 1992).

In terms of production of Kyungsang Korean, a pitch accent language, Lee and Jongman (2010) compared production of the three phonation types in Kyungsang Korean (KK) with that in Seoul Korean. They found that, in KK, F0 was highest after aspirated stops; intermediate after tense stops; and lowest after lax stops, which was consistent with Seoul Korean. Contra the previous assumption, in Seoul Korean, F0 values were distinct enough

for the contrast between lax and aspirated stops, whereas VOT differences were no more informative enough to distinguish the phonation types because of overlap between lax and aspirated stops. This finding was consistent with what Silva (2006) reported about the production of the three-way laryngeal contrast in current Korean. On the contrary, in KK, VOT differences were still significant for the distinction of the phonation types, whereas F0 values could not be a good source for the three-way phonation type contrast because of overlap between tense in low tone condition and lax in high tone condition; between tense in high tone and aspirated in low tone condition. Despite the difference between Seoul Korean and KK, KK and Seoul Korean are similar in that F0 values are useful for the two-way contrast between aspirated and lax stops: F0 is significantly higher after aspirated stops than after lax stops.

2.2 Lexical accent patterns in NKK

The locus of accent is not predictable for a lexical word in NKK, as shown in (1). Aspirated onset consonants are not necessarily associated with a high tone pitch accent as illustrated in the examples in (1).

(1) NKK lexical accentuation irrelevant to onset quality[1]

a. Double accent

t^{h}úgú	‘knight’s helmet’
c^{h}ébí	‘preparation’
hɤ́p^{h}á	‘lung’
k^{h}ídári	‘long leg’

b. Final accent

c^{h}imá	‘skirt’
p^{h}odó	‘grape’
t^{h}acó	‘ostrich’
koc^{h}ú	‘pepper’

c. Penult accent

c^{h}ɤ́ma	‘eaves’
p^{h}ógi	‘head of vegetables’
púp^{h}i	‘bulk’
p^{h}odégi	‘baby blanket’

[1] An anonymous reviewer pointed out that some words in (1) might have variant accent patterns. For example, final accent would be also possible for *t^{h}úgú, c^{h}ébí* and *c^{h}ɤ́ma*. The variant patterns also demonstrate that aspiration is not a factor in the accent placement. The accent patterns in (1) were based on three NKK native speakers’ judgments, who were in their thirties or forties from Daegu. Speakers’ variations on NKK accent patterns may occur due to several factors: age, linguistic background, and etc: for example, C-G Gim (1994) reported that NKK speakers in their sixties and NKK speakers in their twenties produced different accent patterns for some lexical word groups. In addition, patterns of words containing a long vowel were not presented in (1) since this study considered patterns of words with short vowels only.

Bisyllabic/trisyllabic words beginning with aspirated consonants could have all the different possible patterns (final accent as well as double accent and penultimate accent) (e.g. pʰodó, tʰúgú, pʰógi; kʰídári, pʰodégi). In addition, aspirated onset consonants of the final syllable do not necessarily attract accent (kocʰú vs. púpʰi). The aspiration effect on F0 of the following vowel does not play a role in NKK lexical accent patterns.

Without underlying information for the accent position, however, it is plausible that NKK speakers utilize the phonetic effect of prevocalic consonants in cases when accenting newly adopted words. Furthermore, it is also possible that NKK speakers would perceive the pitch difference between aspirated and lax stops as a cue for lexical accent when they encounter new words produced in other dialects (e.g. Seoul Korean, Jeonnam Korean). Taken all these possibilities, onset-sensitive accentuation is hypothesized for accent patterns of newly adopted words in NKK. In order to test the consonantal effects on pitch accent, an experimental study was performed using novel words.

3. Experiment: Aspiration effect test

A hypothesis which guided this study is that accentuation will be sensitive to onsets (c.f. Gordon 2005). Based on the previous finding that F0 was realized significantly higher after aspirated consonants than after lax consonants, the hypothesis predicts that aspirated onset consonants attract accent better than other consonants in novel words if accentuation is sensitive to the association between aspiration and F0.

3.1 Participants

30 subjects, ranging in age from 29 to 54 years (mean 39), participated in this study. Participants were born and grew up in Daegu or in the suburbs in the northern part of Kyungsang province, and most of them lived in the same area at the time of the experiments. 15 were male and 15 were female. They were paid for their participation, which took less than half an hour.

3.2 Materials

The test word set consisted of novel words with four possible combinations of CV syllables for bisyllabic words and for trisyllabic words: NN, AN, NA, AA, NNN, ANN, AAN, NAN (N:CV with a non-aspirated onset; A:CV with an aspirated onset) (e.g. *tapa, tʰapa, tapʰa ,tʰapʰa, kitici, kʰitici, kʰitʰici, kitʰici*). Only obstruent consonants were used for onsets such as *p, t, k* (e.g. *pakapa*, *citiki*) in order to keep aspiration contrast. A single vowel, either *a* or *i*, was used within a word; for example, only the vowel *a* was used as in a word *tapa* or the vowel *i* was used as in a word *kitici*. Four items were included for each combination. In total, 32 words were created:

16 bisyllabic words and 16 trisyllabic words.

(2) Novel stimuli

	Type 1	*Type2*	*Type 3*	*Type 4*
Bisyllabic:	NN	AN	NA	AA
	tapa	t^{h}apa	tap^{h}a	t^{h}ap^{h}a
	kapa	k^{h}apa	kap^{h}a	k^{h}ap^{h}a
	piki	p^{h}iki	pik^{h}i	p^{h}ik^{h}i
	cipi	c^{h}ipi	cip^{h}i	c^{h}ip^{h}i
Trisyllabic:	NNN	ANN	AAN	NAN
	pakapa	p^{h}akapa	p^{h}ak^{h}apa	pak^{h}apa
	takapa	t^{h}akapa	t^{h}ak^{h}apa	tak^{h}apa
	kitici	k^{h}itici	k^{h}it^{h}ici	kit^{h}ici
	citiki	c^{h}itiki	c^{h}it^{h}iki	cit^{h}iki

3.3 Procedure

Participants were recorded in a quiet room using a cardioid condenser lavalier microphone and a Zoom H4 digital recorder at 44.1 kHz sampling rate. They read a randomized list of words given in a Korean carrier sentence, for example "*atɨri* _____ *to satalla* k^{h}*atʌra*" (My son asked me to buy _____ too) with 2 repetitions. The second readings were analyzed. Novel words were presented with pictures of unfamiliar cartoon characters as in (3) and introduced as the names of new cartoon characters which had recently become popular among children.

(3) Example sentence

atɨri  ***tapa*** to satalla k^{h}atəra

'My son asked me to buy ***tapa*** too'

Participants were asked to read the sentences written in Korean characters as natural conversational speech. Each speaker looked through the word list in order to familiarize himself/herself with all the words before recording. Speakers were asked to read in their own dialectal accent.

Accent patterns in target words were judged by two native NKK speakers (the author and an undergraduate linguistics student at Stony Brook University). If disagreement occurred between the two judgments, the accent decision was made based on the pitch contour generated using Praat[2].

[2] The judgments disagreed on 7% of the data (68/951): 27 bisyllabic and 41 trisyllabic tokens. As for trisyllabic words, the disagreement occurred on tokens with a high vowel (e.g. kitici) more often than on tokens with a low vowel (e.g. takapa): 27 of the 41 trisyllabic tokens were the words with a high vowel. Penultimate accent in words with a high vowel was

3.4 Results

A total of 951 tokens were collected from 32 test words with 30 subjects excluding 9 tokens with production errors. 480 tokens were bisyllabic and 471 tokens were trisyllabic. A previous study showed that penultimate accent was predominant in words with all light syllables: 82% in bisyllabic words and 81% in trisyllabic words were given penultimate accent (H-J. Kim, in press). Nevertheless, the hypothesis predicts that non-penultimate accent would be more frequent in the combinations having aspirated onsets in non-penultimate syllables such as NA, ANN than in other combinations such as NN, AN, NNN, NAN, because aspirated onset consonants would attract accent. The overall results of bisyllabic words are presented in Figure 1. Penultimate accent was the most frequent pattern (80%), double accent was assigned fairly less (14%), and final accent was rarely given (6%) in bisyllabic words.

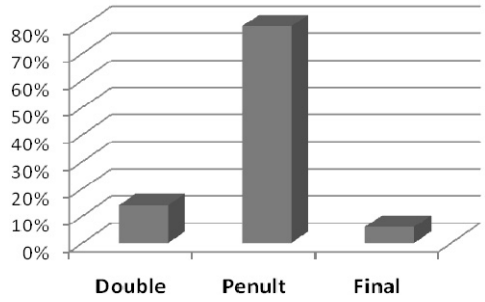

Figure 1. Overall results in bisyllabic words

Accent distribution of each combination also showed the patterns similar to that of overall results. As shown in Table 1, penultimate accent was the most common across all the combinations: 81% in NN; 88% in AN; 72% in NA; 78% in AA. Double accent was given around 15% of the time in most combinations: 17% in NN; 11% in AN; 14% in NA; 16% in AA. Final accent was very rare since few words were given final accent in most combinations except in NA combinations.

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often misperceived as double accent. I assume that this would be because the words began with a relatively higher F0 than words with a low vowel. Yet, there was no particular tendency for bisyllabic words.

Table 1. Results according to syllable combinations in bisyllabic words

	Double	Penult	Final	Total
NN	20 (17%)	**97 (81%)**	3 (2%)	120 (100%)
AN	13 (11%)	**106 (88%)**	1 (1%)	120 (100%)
NA	17 (14%)	**87 (72%)**	16 (13%)	120 (100%)
AA	19 (16%)	**94 (78%)**	7 (6%)	120 (100%)
Total	69 (14%)	**384 (80%)**	27 (6%)	480 (100%)

To compare the distribution of accent between combinations, statistical analyses using Pearson's Chi-square were performed. The results showed that the distribution of accent in AN combinations was not different from that of NN ($\chi^2(2)=2.88$, p=.24), which suggests that aspirated consonants in the onset of the initial syllable do not disturb the typical accentuation of NN. However, the distribution of accent was significantly different between NN and NA ($\chi^2(2)=9.68$, p=.008) and between AN and AA ($\chi^2(2)=6.35$, p=.04). Final accent is more frequent in NA than in NN and penultimate accent is less frequent in AA than in AN, due to the increase of double accent and final accent. This suggests that onset aspiration of final syllables is a factor to induce non-penultimate accent in words with light syllables. Figure 2 illustrates the different accent distributions between NN and NA, and between AN and AA combinations.

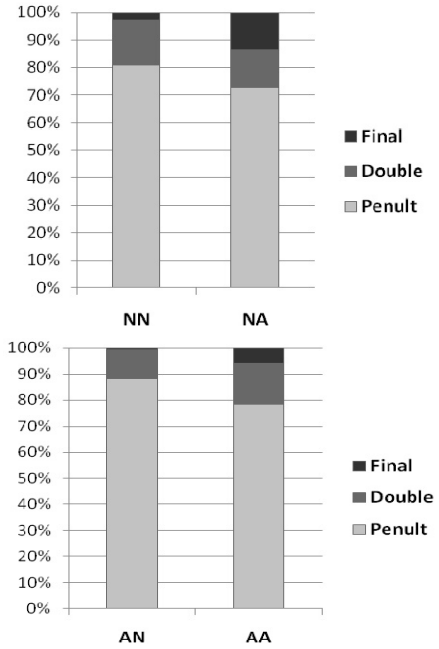

Figure 2. Accent distribution in bisyllabic words

As shown in Figure 2, final accent was assigned more frequently in NA and AA combinations.

The distribution of each accent pattern is given in Figures 3 and 4. Double accent was distributed evenly for all the combinations: 29% (NN); 19% (AN); 25%(NA); 27%(AA). This suggests that double accent placement is not influenced by the quality of onset consonants in bisyllabic words. Penultimate accent also showed similar results with double accent assigned relatively equally for all the combinations: 25% in NN; 28% in AN; 23% in NA; 24% in AA. This suggests that onset quality did not matter in the assignment of double accent and penulitmate accent in bisyllabic words.

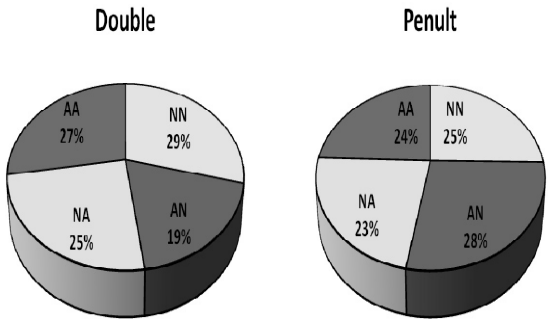

Figure 3. Even distribution of double accent and of penultimate accent in bisyllabic words

On the other hand, as shown in Figure 4, the distribution of final accent was skewed to NA combinations: 59% of final accented words were NA combinations, 26% were AA combinations and the rest 15% were NN and AN combinations. Final accent was fairly rare in words having only light syllables: only 27 words out of 480 words (6%) were given final accent. However, of the 27 final accented words, 23 words (85%) had aspirated onsets in the final syllable (NA; AA). The distribution of final accent clearly demonstrates that final accent was not assigned randomly but rather was affected by the phonetic quality of onsets in final syllables, despite avoidance of final accent.

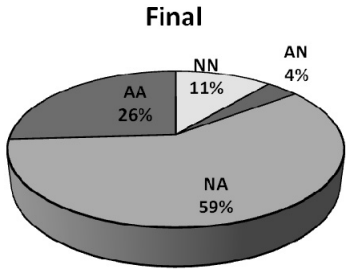

Figure 4. Uneven distribution of final accent in bisyllabic words

The overall results for trisyllabic words were also similar to the patterns of bisyllabic words, as shown in Figure 5. Penultimate accent was most frequent (65%), double accent was less common (32%), and final accent was least frequent (4%).

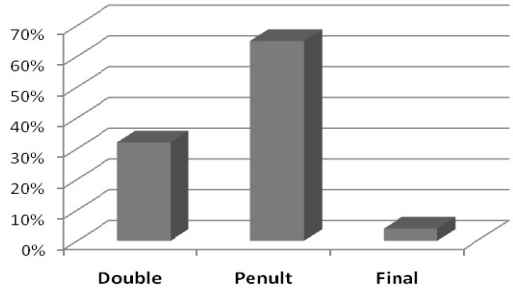

Figure 5. Overall results in trisyllabic words

Table 2, however, showed that the patterns for different syllable combinations were different from those of bisyllabic words. When a word-initial consonant was aspirated, double accent was more likely: 52% of ANN combinations were given double accent, which contrasted with the dominant penultimate accentuation in other combinations. The patterns in the other combinations complied with overall patterns in that penultimate accent was most common.

Table 2. Results according to syllable combinations in trisyllabic words

	Double	Penult	Final	Total
NNN	24 (20%)	**90 (76%)**	5 (4%)	119 (100%)
ANN	**62 (52%)**	55 (46%)	3 (3%)	120 (100%)
AAN	41 (36%)	**70 (61%)**	4 (3%)	115 (100%)
NAN	22 (19%)	**90 (77%)**	5 (4%)	117 (100%)
Total	149 (32%)	**305 (65%)**	17 (4%)	471 (100%)

Figure 6 clearly illustrates that accent distribution was not consistent across syllable combinations in trisyllabic words.

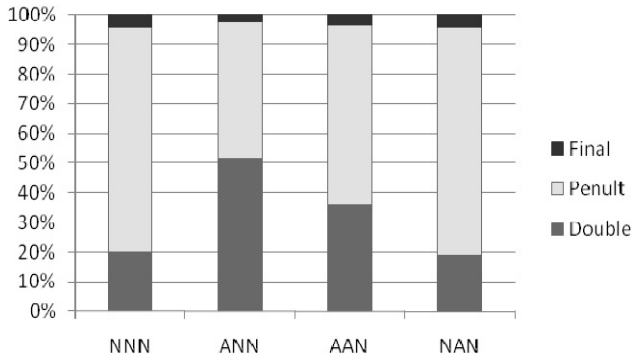

Figure 6. Distribution of accent according to syllable combinations in trisyllabic words

Double accent was more frequent in ANN and AAN combinations than in other combinations. Penultimate accent was predominant in NNN and NAN combinations but not in ANN and AAN combinations, whereas final accent was rare across all the combinations.

The following graphs in Figure 7 show that the onset quality of word-initial syllables influenced accent placement, by comparing accent patterns between NNN and ANN, and between NAN and AAN.

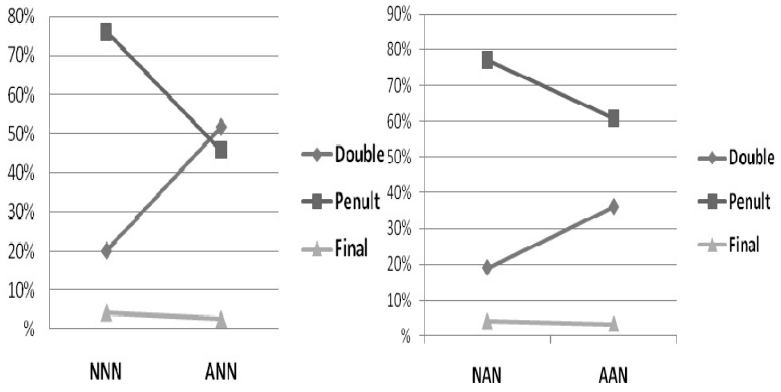

Figure 7. Accent placement in NNN vs. in ANN; in NAN vs. in AAN

Double accent was more common in ANN and AAN than in NNN and NAN, while penultimate accent was less common in ANN and AAN than in NNN and NAN. Pearson's Chi-square analyses confirmed that the differences between NNN and ANN and between NAN and AAN were statistically significant ($\chi^2(3)=26.74$, $p<.001$; $\chi^2(3)=8$, $p<.05$).

To summarize, penultimate accent was preferred both in bisyllabic words and in trisyllabic words. However, the predominant penultimate accentuation was disturbed in trisyllabic words when the word began with aspirated onset consonants: only 46% of trisyllabic words with word-initial aspirated onsets received penultimate accent while 76% of words without aspiration onsets received penultimate accent. As for bisyllabic words, aspirated onsets in word-initial syllables did not bring about a change in accent patterns. This is not surprising because word-initial aspirated onsets in bisyllabic words do not create a conflict with the preferred penultimate accent position. However, 13% of words containing aspirated onsets in the final syllable received final accent. The difference between final accent in NA and in NN was statistically significant since final accent was very rare in words with all light syllables (2%).

These results suggest that NKK speakers are sensitive to onset quality when they accent novel words. Although the consonantal effect on accentuation was not categorical, the phonetic effect was important enough to serve as a factor in deriving variation in accent patterns in newly adopted words. For example, variations of accent patterns found in exisitng loanwords as in *nepk^{h}ín* 'napkin' with final accent and *k^{h}épt^{h}ín* 'captain' with double accent might be ascribed to this phonetic effect. Some speakers accent new words more by following a favored position, which will produce dominant penultimate accentuation, while other speakers are more sensitive to the association between aspiration and higher F0 and apply it to accentuation of new words.

4. Phonetic characteristics of onset-sensitive accent

Acoustic analyses were conducted to examine phonetic characteristics of accented vowels and unaccented vowels of ANN and of NNN. This study was initiated to confirm accuracy of the accent judgments because the results of the previous section were based on aural judgments. Furthermore, this study also investigated what other phonetic cues besides F0 were available for the accentual contrast between penultimate accent and double accent in cases when F0 was higher in low toned vowels (V1 following asprated consonants in ANN with penultimate accent) than high toned vowels (V1 following unaspirated consonants in NNN with double accent).

This study was guided by a hypothesis that phonetic characteristics are distinct between accented vowels and unaccented vowels of ANN and of NNN if misperception was not involved in the accent judgments. More specifically, we predict that ANN with double accent will manifest different phonetic patterns (e.g. F0 values or F0 contour) from ANN with penultimate accent just as NNN with double accent does from NNN with penultimate accent. Average F0 and F0 contours of the vowel in the first syllable (V1) in ANN/NNN with double accent (**High** tone category since the target initial syllable has a high tone) and in ANN/NNN with

penultimate accent (**Low** tone category since the target initial syllable has a low tone) were compared using a repeated-measures analysis of variance (ANOVA). The dependent variable was the mean F0 of the vowel in each syllable of the target word. The independent variables were onset type of the first syllable (aspirated vs. unaspirated) and tone of the first syllable (high vs. low).

4.1 Materials

464 tokens, collected in the experiment, were analyzed: 4 ANN words and 4 NNN words with 2 repetitions recorded by 15 male and 15 female speakers[3].

(4) Target item list

ANN	NNN
c^hitiki	citiki
k^hitici	kitici
p^hakaba	pakapa
t^hakaba	takapa

4.2 Measurements

The following measurements were taken: average F0 in V1 of all the tokens measured at four points (1/4, 2/4(midpoint), 3/4, 4/4(offset)), and average F0 in V2 and V3 measured at midpoint of the target vowel. Average F0 was measured by selecting the span of the vowel in the acoustic display and allowing Praat to automatically calculate the desired value. Then the following values were compared: F0 contours and average F0 in V1 of ANN (High) having double accent and in V1 of ANN (Low) having penultimate accent. In addition, F0 contours and average F0 in V1 of NNN (High) having double accent and in V1 of ANN (Low) having penultimate accent were also compared.

4.3 Results

The patterns of ANN and NNN were compared according to tone category (High vs. Low) and onset type of the first syllable (aspirated vs. unaspirated) using a repeated-measures analysis of variance (ANOVA). Average F0 values of V1 in NNN and in ANN measured at the midpoint were presented in Table 3. In addition, the comparison of mean F0 between low toned V1 (V1 of tokens with penultimate accent (LHL)) and high toned V1 (V1 of tokens with double accent (HHL) was also shown in Table 3.

[3] One male speaker produced only one repetition while the other 29 participants repeated twice and 8 items were excluded from the analyses due to production errors or devoiced vowels.

Table 3. Compared mean F0 of V1 in NNN vs. in ANN; in LHL(penult) vs. in HHL(double)

	Male		Female		N
	Mean F0 (Hz)	S.D	Mean F0 (Hz)	S.D	
NNN	127.7	21.2	217.1	21.2	30
ANN	162.2	24.1	275.3	37.8	30
LHL	128.9	25.4	228.4	50.1	26
HHL	164.4	24.5	280.2	40.2	26

As shown in Table 3, the aspiration effect on F0 values was significant: the F0 of V1 in NNN is consistently lower than the F0 of V1 in ANN, for both male and female speakers (male: $F(1,14)=88.4$, $p<.001$; female: $F(1,14)=41.8$, $p<.001$). The tonal effect on F0 values was also significant: the F0 of V1 in LHL (ANN/Low; NNN/Low) is significantly lower than in HHL (ANN/High; NNN/High) (male: $F(1,11)=21.7$, $p=.001$; female: $F(1,13)=36.5$, $p<.001$).

Table 4 presents average F0 values of V1 measured at the midpoint according to each tone (H;L) for each word type (NNN;ANN).

Table 4. Comparison of mean F0 between low toned V1 and high toned V1 for each word type

	Male				Female			
	NNN		ANN		NNN		ANN	
	L	H	L	H	L	H	L	H
Mean F0(Hz)	114.5	134.9	143.5	159.6	196.1	212.3	254.4	267.9
S.D	14.4	22.9	22.0	29.1	15.0	7.7	35.2	36.5
N	15	3	13	13	15	8	12	14

The tonal effect on the F0 of V1 in ANN was statistically significant (Male: $F(1,9)=5.98$, $p=.04$; Female: $F(1,10)=61.4$, $p<.001$). As shown in Figure 8, F0 values were consistently lower in ANN (Low) than in ANN (High), even if F0 begins with relatively higher F0 in ANN (Low). The tonal effect was also found in NNN groups: F0 values were consistently higher in NNN (High) than in NNN (Low). In terms of F0 values, four distinct levels were generated for each category: NNN (Low) < NNN (High) < ANN (Low) < ANN (High). The following figures illustrate distinct F0 levels of V1 for each category.

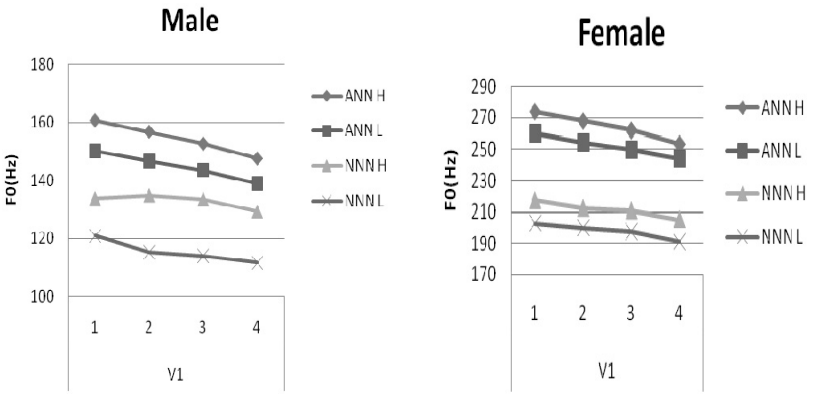

Figure 8. Distinct F0 values of V1 for ANN (High; Low) and NNN (High; Low)

In terms of distinction of low toned V1 in ANN from high toned V1 in NNN, F0 of the vowel might not be sufficient for the tonal contrast since the F0 of low toned V1 in ANN was consistently higher than that of high toned V1 in NNN. Thus, I compared F0 contours of the four categories.

The pitch contour shapes in Figure 9 generated from average F0 at the midpoint of each syllable clearly demonstrate the distinct patterns of each category. Only the graphs for female speakers are presented, since the patterns of male speakers were consistent with them.

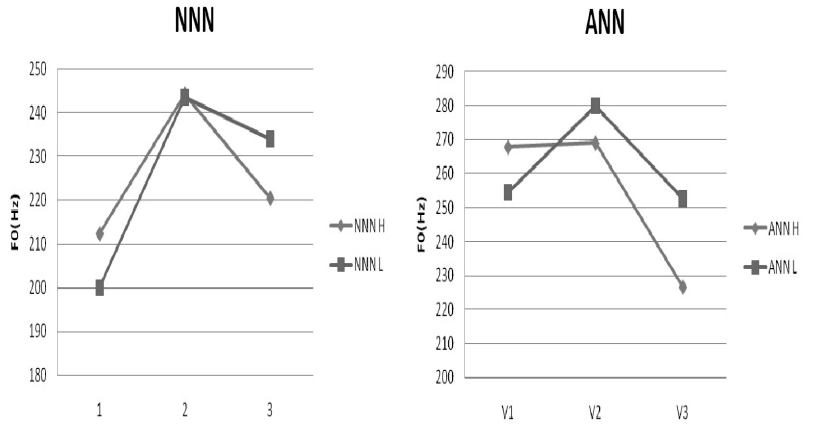

Figure 9. Pitch contour patterns of NNN and ANN:
Double accent(H) vs. Penult Accent(L)

The pitch peak was on the second syllable in both NNN(High) and NNN(Low), but the high tone began higher than the low tone in the first

syllable. Recall that NNN (High) words contained only lax onsets with double accent (HHL) while NNN (Low) words had penultimate accent (LHL). While the final syllable in both categories had a low tone, the pitch fall was steeper in NNN (High) than in NNN (Low). The patterns shown in NNN novel words were consistent with D-M Lee (2008)'s description of the phonetic characteristics of NKK tone patterns based on trisyllabic existing words beginning with sonorant onsets: the pitch of the second syllable was higher than that of the first syllable in double accent (high category), and no deep fall was found after the peak in the third syllable in penultimate accent (low category)[4]. On the other hand, when a word began with an aspirated onset, the pitch was elevated in the beginning, forming a pitch plateau in ANN(High), which resulted in a different contour shape from NNN (High). The pitch fell steeply in ANN (High), while the pitch fall was much less steep in ANN (Low). Therefore, the pitch contours of each category can be characterized as follows:

(5) Characteristics of pitch contours
ANN (High): pitch plateau with steep pitch fall on the third syllable
ANN (Low): pitch peak on the second syllable and less steep pitch fall on the third syllable
NNN (High): pitch peak on the second syllable but steep pitch fall on the third
NNN (Low): steep rise to the pitch peak on the second syllable and gentle fall on the third

Both ANN (Low) and NNN (High) have a pitch peak on the second syllable, but ANN (Low) has a gentle pitch fall on the third syllable, characteristic of penultimate accent, whereas NNN (High) has a steep pitch fall of double accent on the third syllable. Even though the F0 of ANN (Low) began higher than that of NNN (High), the distinct pitch contour shape of penultimate accent indicated that the initial syllable of ANN (Low) had a low tone.

To sum up, the phonetic qualities of ANN/NNN (High) were distinct from those of ANN/NNN (Low): i) averaged F0 values of the vowel in the initial syllable in ANN/NNN (High**)** were significantly higher than those in ANN/NNN (Low); ii) the pitch contour of ANN (High) was distinct from that of ANN (Low): ANN (High) began with a pitch plateau at a higher F0 and ended with steep pitch fall, whereas ANN (Low) began with a lower F0 but had a steep pitch rise to the second syllable; iii) the pitch contour of NNN (High) was also different from that of NNN (Low): the pitch peak was on the second syllable in both NNN(High) and NNN(Low), but the high tone began higher than the low tone in the first syllable and the pitch fall was steeper in NNN (High) than in NNN (Low). These results suggest

[4] D-M Lee did not use words beginning with an aspirated consonant in his study, so the patterns of ANN existing words were not found yet.

that the phonetic information on the surface was sufficient to cue the distinction between ANN (High) and ANN (Low). Therefore, we can assume that accent was accurately identified, and that accentuation was indeed affected by onset aspiration.

5. Discussion

This study provided evidence that aspiration plays a role in NKK accentuation of novel words, even though aspirated onsets are not necessarily associated with a high tone pitch accent in NKK lexical accentuation. Acoustic analyses showed that phonetic patterns of vowels with aspirated onsets, judged as accented, were clearly distinct from those of the vowels judged as unaccented, confirming that phonetic information was sufficient for the accentual contrast. However, the onset-sensitive accentuation was not categorical, instead being associated with variations in the accent patterns of newly adopted words. This suggests that a phonetics-based source would serve as one of the factors to motivate NKK accent placement of novel words.

5.1 Onset-sensitive patterns vs. onset-insensitive patterns

Penultimate accent was preferred both in bisyllabic words and in trisyllabic words when a word consists of only light syllables. However, predominant penultimate accentuation was disturbed in trisyllabic words when a word beginning with aspirated consonants was included: 46% of trisyllabic words with word-initial aspirated onsets were produced with penultimate accent, while 76% of words without aspiration onsets were with penultimate accent. In bisyllabic words, aspiration on the initial onset consonant did not influence on accent placement of novel words. I assume that this is because accent on the word-initial syllable with an aspirated onset does not create a conflict with the preferred penultimate accent in bisyllabic words. However, when final syllables had aspirated onsets, final accent was more frequent (13%), which was statistically significant, compared to 2% of the words without aspirated onsets, which had final accent. These results suggest that onset quality was relevant to accent patterns in novel words. Some speakers accent new words more restictively following a default position, which will produce dominant penultimate accent, while some speakers would be more sensitive to the association between aspiration and higher F0 and produce onset-sensitive accent patterns in newly adopted words.

5.1.1 Default penultimate accent

The predominant penultimate accentuation in trisyllabic words is

consistent with a default accent pattern[5], which is proposed by N-J Kim (1997). The default penultimate accent can be identified by the constraints in (6).

(6) Constraints for default penultimate accent (based on N-J Kim 1997)
*Accentless: No word without accent is allowed (A word must have a high tone accent).
Align-R: Align the right edge of a high tone with the right edge of a word.
Nonfinality: No high tone on the final syllable of a word is allowed.
* H: No syllable with a high tone is allowed.

The default accent position is determined by the ranking of the constraints presented in (7) and the accent assignment via this ranking is illustrated in (8).

(7) *Accentless >> Nonfinality >> Align-R>>*H

(8) Default penultimate accentuation

Input: /takapa/	*Accentless	Nonfinality	Align-R	*H
a. takapa	*!			
b. takapá		*!		*
c. tákapa			**!	*
d. tákápa			*	**!
→e. takápa			*	*

Novel words are assumed to have no underlying high tone accent. Accent must be assigned to satisfy the constraint *Accentless. As shown in (8), the constraint Nonfinality ranked higher than Align-R forces the candidate with final accent (8b) to be out. Antepenultimate accent (8c) loses because it violates Align-R twice. Double accent (8d) cannot make an optimal output because it violates *H twice. Therefore, penultimate accent (8e) becomes a winner despite the violation of Align-R and *H.

[5] Among previous studies, N-J Kim (1997) separated lexical words into three different groups according to accent patterns: words with antepenultimate accent and final accent belong to a "prelinked tone" group of which a high tone is prelinked in the underlying representation (UR); words with double accent belong to a "floating tone" group where a high tone is floating in UR; words which have no high tone in UR belong to a "default tone" group. He argues that a default high tone would fall on the penultimate syllable when a word does not contain a long vowel. If final syllables contain a long vowel, then a default high tone would fall on the final.

5.1.2 Onset-sensitive accentuation

When a word-initial syllable contains aspirated consonants, double accent was more likely: 52% of ANN combinations were given double accent, which contrasted with the dominant penultimate accentuation in other combinations. The constraints in (6) are not satisfactory to predict this context-sensitive patterning. A constraint which prohibits a syllable with an aspirated onset consonant from having a low tone is motivated to account for this onset-sensitive accentuation. The association of aspiration with a high tone is also attested cross-linguistically. For example, S-H Lee (2008) showed that a high tone is only allowed for syllables with aspirated onsets in Mulao, a language spoken in the Guangxi Zhuang Autonomous Region in southwest China (e.g. [p^hó^{44}] 'bed' H tone vs. *[p^ho] L tone). S-H Lee argues that "consonant-tone interaction results from the requirement that all segments in the output must be associated to a tone, which is ensured by the markedness constraint $R_{OOT}N_{ODE}$ →T"(p.129), providing another evidence from Burmese where coda consonants restrict tonal realization: syllables with a glottal stop coda are not allowed to have a high tone ([k^haʔ] 'to draw off' L tone vs. *[k^háʔ] H tone). Therefore, all segments are under a dependency relationship with tone. According to S-H Lee, a markedness constraint *[+$S_{PREAD}G_{LOTTIS}$]/Low in (9) accounts for the association of aspiration with a high tone, which penalizes aspirated consonants with a low tone in the output.

(9) *[+$S_{PREAD}G_{LOTTIS}$]/Low (S-H Lee 2008, p141)
No consonant specified as [+$S_{PREAD}G_{LOTTIS}$] associates to L tone in the output.

In NKK, the preference for double accent in ANN can be explained by the constraint *[+$S_{PREAD}G_{LOTTIS}$]/Low, which forbids syllables with aspirated onset consonants to be associated with a low tone. However, a question arises: why is not antepenultimate accent but double accent assigned although antepenultimate accent satisfies this constraint? I propose that the preference for double accent to antepenultimate accent in ANN results from conspiracy of the constraints Align-R and *[+S_{PREAD} G_{LOTTIS}]/Low. Tableau (10) illustrates the onset-sensitive accent patterns and how double accent wins over antepenultimate accent in ANN.

(10) Onset-sensitive accentuation

Input: /t^hakapa/	Nonfinality	Align-R	*[+$S_{PREAD}G_{LOTTIS}$]/ Low	*H
a. t^hakápa		*	*!	*
b. t^hakapá	*!		*	*
c. t^hákapa		**!		*
☞d. t^hákápa		*		**

The candidates (10a) and (10b) with penultimate accent/final accent lose because of a violation of *[+$S_{PREAD}G_{LOTTIS}$]/Low and of Nonfinality respectively. The candidate (10c) with antepenultimate accent also loses because it violates Align-R twice, although it satisfies *[+S_{PREAD} G_{LOTTIS}]/Low. Finally, the double accented candidate (10d) makes an optimal output. If a NKK speaker produced accent sensitively to the association of aspirated consonants with a high tone, the constraint *[+$S_{PREAD}G_{LOTTIS}$]/Low must outrank the constraint *H in his/her grammar. If a NKK speaker preferred penultimate accent regardless of onset quality, s/he must have a grammar which demotes the constraint *[+S_{PREAD} G_{LOTTIS}]/Low lower than the constraint *H.

(11) Onset-insensitive accentuation

Input: /t^{h}akapa/	Nonfinality	Align-R	*H	*[+$S_{PREAD}G_{LOTTIS}$]/ Low
☞a. t^{h}akápa		*	*	*
b. t^{h}ákápa		*	*!*	

As shown in (11), penultimate accent (11a) becomes a winner despite violation of the constraint *[+$S_{PREAD}G_{LOTTIS}$]/Low because the constraint *[+$S_{PREAD}G_{LOTTIS}$]/Low is not crucial in the accentuation in this grammar.

5.2 Alternative account: dialectal influence?

The effect of aspiration on the F0 of a following vowel has been considered as one of the features signaling the phonation type contrast among lax, tense and aspirated stops in standard Korean. Voice onset time (VOT) has also been assumed to be a robust phonetic characteristic for the laryngeal contrast. However, Silva (2006) recently claimed that the phonetic implementation for the contrast has changed over the past two generations: the VOT distinction between lax and aspirated stops has been neutralized for some younger speakers and F0 has been utilized as a primary cue for the distinction between lax and aspirated stops. Silva argued that contemporary Seoul Korean, which is not a pitch accent/tone language, has recently developed a tonal system to encode the phonemic contrast between lax and aspirated stops: lax stops are associated with a low tone while aspirated stops are marked with a high tone. Silva's argument is supported by a perception study (M-R Kim *et al.* 2002), which showed that stop identification was strongly determined by information on the vowel (F0) rather than on the consonant (VOT), with low F0 cueing lax stops and higher F0 cueing aspirated stops. Therefore, for the two-way contrast between lax stops and aspirated stops, vowel F0 is sufficient to cue the distinction. Considering that the onset sensitive NKK accentuation of novel words was in accordance with the changed phonetic implementation of the stop contrast in contemporary standard (or Seoul) Korean, it is

plausible that NKK speakers would perceive the tonal effect of aspirated and lax stops as a cue for lexical accent when they encounter new words spoken in standard Korean or other dialects and apply it in NKK accent placement.

6. Conclusion

Aspirated onset consonants are not necessarily associated with a high tone pitch accent in North Kyungsang Korean although vowels following aspirated obstruent consonants tend to have higher F0 than those following other consonants. However, the current study presented evidence that aspiration plays a role in the assignment of a high tone pitch accent to novel words. Although penultimate accent was preferred both in bisyllabic words and in trisyllabic words, the predominant penultimate accentuation was disturbed in trisyllabic words when a word began with aspirated onset consonants. As for bisyllabic words, final accent was more frequent when final syllables contained an aspirated onset consonant.

This study suggests that even though the effect of aspiration on accentuation was not categorical, the phonetic effect was important enough to serve as a factor in deriving variation in accent patterns in newly adopted words. The results suggest that accent patterns of words without underlying accent would not be restricted to penultimate accent. Penultimate accent is optimal only when a word does not contain aspirated consonants. Double accent or final accent would be variant forms for some cases when a word contains an aspirated consonant in the initial syllable or in the final syllable. The association of aspiration with a high tone is ascribed to a constraint, *[+$S_{PREAD}G_{LOTTIS}$]/Low. Namely, some speakers who are more sensitive to the association between aspiration and higher F0 would have a grammar which ranks the constraint *[+$S_{PREAD}G_{LOTTIS}$]/Low higher than other constraints, e.g. *H. On the other hand, other speakers who are not sensitive to the phonetic effects would have the constraint *[+$S_{PREAD}G_{LOTTIS}$]/Low demoted in their grammar, which will produce dominant penultimate accentuation.

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