Boundary and pitch effects on the perception of Korean alveolar nasal*

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Kang, Hyunsook. (2016). Boundary and pitch effects on the perception of Korean alveolar nasal. *The Linguistic Association of Korea Journal*, *24*(4), 23-38. This study investigates alveolar nasal perception on various portions of two Korean [ni] sequences: one [ni] sequence in the suffix medial position of *-mnita* with L tone and the other [ni] sequence at the IP-final position *-ni* with H tone. The perception test results show that various portions of [ni] from the suffix-medial position induce significantly more errors than the corresponding portions of [ni] from the IP-final position in all three conditions (vowel, murmur-vowel, and the whole phrase). The test results also show that suffix-medial [ni] sequences of some speakers obtain near-perfect perception scores as [mi], showing that [n] has undergone the categorical change to [m]. This shows that unlike the traditional assumption, Korean may allow progressive place assimilation if the target is the least prominent segment in the environment, like an alveolar nasal [n] in the context of /nasal__i/.

Key Words: alveola nasal perception, different prosodic categories, progressive place assimilation

1. Introduction

Studies on the perception of place of articulation of nasal consonants have shown that a different amount of place information is contained in different portions of a nasal-vowel sequence. Some researchers (Liberman et al., 1954;

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Malécot, 1956) have argued that transitions are key elements in the identification of place of articulation in nasal consonants, while others (cf. Kurowsky & Blumstein, 1984; Recasens, 1983) have argued that murmurs provide a significant amount of place information as well as transitions.

Furthermore, it was revealed that the perception of place of articulation of a nasal consonant in a nasal-vowel sequence is very much influenced by the vowel. Specifically, place of articulation of a nasal is argued to be poorly perceived in the environment of vowel [i]. For example, Kurowsky and Blumstein (1984) and Repp (1986) showed that when the murmur was presented alone as a stimulus, the murmur [m] was confused as the murmur [n] more often before vowel [i] than before other vowels. Repp (1986) suggested that this was due to the coarticulatory effects: the anticipation of the following vowel [i] would be evident in [m] murmurs by the elevated tongue body for the following vowel [i], making [m] murmurs acoustically similar to [n] murmurs (cf. Ohala, 1984).

Kurowsky and Blumstein (1984) also showed that when a vowel was presented alone as a stimulus, many errors were made in the perception of [n] in the context of [i e]. Repp (1986) also confirmed that when a vowel was presented alone, [(n)i] suffered more than any other syllable in the perception of place of articulation. Repp (1986) explained that this was due to the difference in the transition length. From the occlusion of [n] to the following vowel configuration, the tongue traversed more distance to the back vowel than to the front vowel [i]. As a result, the long transition occurred from the occlusion of [n] to the steady-state vowel portion of the back vowel with large F2 difference while the short transition occurred from the occlusion of [n] to the steady-state vowel portion of the front high vowel [i] with little F2 difference, resulting in many errors in perception.

Kurowsky and Blumstein (1984) also showed if the stimulus contains the last three pulses of the murmur (short murmur) and first three pulses of the vowel, both [n] and [m] were more confused for each other before [i] than before [e a o]. Repp (1986) suggested that F2 difference at the transition from the murmurs to the vowel is responsible for the confusion. There are large differences in F2 onsets between [mu] and [nu], and [ma] and [na]. However, there is minimal difference between [mi] and [ni] at the transition.

The confusion between [m] and [n] before vowel [i] is also observed in six-month-old infants. Hillenbrand (1984) showed that six-month-old infants could well perceive the similarities in place of articulation of nasal consonants before [a u] but some infants showed poor performance of perception of place of articulation when nasal consonants occurred before [i].

It was also evidenced by historical sound change. For example, Ohala (1984) argued that the word [mjɛstɔ] 'town' in Standard Czech changed to [nɛstɔ] in East Bohemian due to confusion in perception.

As the perception of a nasal before vowel [i] often results in misperception, this paper examines whether the confusion of place of articulation of nasal in the environment of [i] also occurs in Korean by investigating [ni] sequences. Since Korean does not allow a word-initial [ni] sequence except in newly adapted foreign words, two [ni] sequences this paper examines come from the suffixes. As for the preceding environment, the [am] sequence that ends with a labial nasal is selected. It is expected that the confusion in the perception of the [ni] sequence will increase due to the preceding nasal [m] with labial place of articulation.

The results of this perception test will give us an opportunity to examine the full spectrum of place assimilation in Korean. Korean has optional regressive place assimilation rule. For example, if an alveolar consonant occurs before a labial or a velar consonant, an alveolar nasal undergoes the place assimilation as in /c^{h}an-mul/--> [c^{h}ammul] 'cold water' and /cən-ki/--> [cəŋki] 'electricity'. No progressive place assimilation is reported in Korean, and thus, /kam-næ/; 'endurance' always becomes [kamnæ], but never *[kammæ].

Therefore, if the perceptual confusion of [n] before vowel [i] occurs in Korean, we may observe many responses of [ammi] in the /amni/ sequence. In contrast, if the progressive place assimilation is never permitted in Korean, we may not observe many responses of [ammi]. The perceptual results of the experiment in this paper may offer some answers for these conflicting tendencies.

In addition, this paper will investigate whether prosodic factors such as the prosodic position (cf. Krivokapić & Byrd, 2012; Cho, 2016) or the linguistic factor such as a stress (cf. Ladefoged & Johnson, 2015) may affect the perception of the [ni] sequences in Korean. It is well known that the segments occurring at the

higher prosodic boundary like the IP-final are longer than those occurring at the lower prosodic boundary, attracting attention. A stressed syllable often shows greater loudness, higher pitch, and/or greater length (cf. Ladefoged & Johnson, 2015), becoming perceptually salient.

Perceptually salient segments are more resistant to phonological rules. For instance, a vowel in the non prominent position as in an unstressed position often undergoes neutralization to schwa, losing its distinctive characteristics (cf. ecó[ɑ]nomy vs. ec*o*[ə]nómical), or deletion (cf. gen*e*ral--> [ʤɛnərəl], [ʤɛnrəl]) in English unlike a vowel in the prominent stressed position. Thus, it is reasonable to assume that nasal-vowel sequences occurring at various prosodic positions and/or containing different linguistic characteristics are likely to be articulated differently from one another and may cause a different type and/or different amount of confusion in sound.

The two [ni] sequences that this paper will examine have a different prosodic category and a different pitch from each other: one [ni] sequence occurs suffix-medially in *-mnita* 'stative suffix' with L tone and the other [ni] sequence, a monosyllabic *-ni* 'question marker', occurs at the IP-final position with H tone. The expectation is that if there is perceptual confusion in the perception of [n] before [i], the [ni] sequence with prominence such as at the IP-final position and H tone would be more resistant to perceptual confusion than the other non-prominent [ni] sequence in the suffix-medial position with L tone.

Finally, we will examine the variation ranges of confusion of [n] as [m] among speakers. In particular, we will see whether different degrees of confusion of alveolar nasal [n] occurs among speakers and if so, what the implication of different degrees of confusion is.

This paper is organized as follows: In Section 2, we will conduct an experiment on the perception of two [ni] sequences in Korean and show the results. Section 3 will discuss the implications of the perceptual results in terms of Korean phonological processes and the prosodic strength.

2. Experiment

2.1. Stimulus

For the stimuli in the perception experiment, twelve native speakers of Korean who use the standard Seoul dialect were recruited. The speakers were six men and six women, and their ages ranged from 21 to 25 (mean= 22.4). The speakers were instructed to pronounce the sentences at a normal speed. The stimuli for this experiment were made using the verbal phrases occurring at the final position of two sentences, *uli motunin 'aka' Tala hamnita* "We act following 'aka'" and *əTəhke yoŋkie mulil tamni?* "How do you put water in the container?" In the first sentence, the [ni] sequence occurs as a part of a suffix *-mnita* 'stative suffix', and this suffix *-mnita* is added to a vowel-final verb *ha-* 'do', resulting in an [amni] sequence. Specifically, this *-ni* sequence occurs suffix-medially and carries a low tone. In the second sentence, the [ni] sequence occurs as a monosyllabic 'question marker' suffix. This *-ni* suffix is added to the verbal stem, *tam-* 'put', resulting in another [amni] sequence. This *-ni* sequence occurs at the IP-final position with a H tone indicating 'question'. These two [ni] sequences were selected for this experiment since they are quite contrastive to each other with different prosodic features.

From these [ni] sequences in *-hamnita* and *-tamni*, we generated two types of computer-edited stimuli following Kurowsky and Blumstein's (1984) methodology. The two types were the stimulus in the V condition and the stimulus in the NV condition: 1) The stimulus in the V condition – from the discontinuity from the murmur to the end of the phrase, *-ita* or *-i*, including the vowel transitions and the discontinuous waveform, and 2) the stimulus in the NV condition – the combination of the stimulus in the V condition and the preceding 30 ms (28-32 ms) of the murmur [n], *-nita* or *-ni*. In addition to these two types of stimuli, we added the third total condition stimulus, the whole phrase.

2.2. Participants

Twenty-five Korean participants who speak the Standard Seoul dialect were recruited for the experiment (seventeen women, eight men). All participants were students at a university. They were aged 20 to 27 (mean=23.8). None of the

participants reported any hearing problems, and they were all paid for their participation.

2.3. Procedures

Participants were tested individually in a quiet office using Praat, a linguistic software application, installed in a computer. The order of the presentation of tokens was counterbalanced across participants. The participants were instructed to press the button that corresponded with the sound they heard over the headphones (Sennheiser HD 590). The buttons were labeled "함니다 함미다 한니다" for the stimuli of the Total condition of *-hamnita* (representing [hamnita], [hammita], and [hannita], respectively) and "담니 담미 단니" (representing [tamni], [tammi], and [tanni], respectively) for the stimuli of the Total condition of *-tamni*. For the stimuli of the remaining two conditions (V & NV conditions), the options were "니다, 미다" (representing [nita] and [mita], respectively) when the stimuli were from *-hamnita,* and "니, 미" (representing [ni] and [mi], respectively) when the stimuli were from *-tamni*. A stimulus in each condition was repeated twice, and participants were instructed to choose one option. There was a 3 second silence between test stimuli and a 30 second silence after each block of twelve stimuli. Each test lasted for less than 20 minutes, and it was a forced-choice test. A total of 1800 items (12 speakers X 2 stimuli X 3 conditions (V-condition, NV-condition, Total-condition) X 25 listeners) were analyzed.

2.4. Results

Tables 1 and 2 show the mean percentages of the identification scores for the alveolar nasal in two prosodic positions. A three-way ANOVA with repeated measures was conducted in which the P-Category (IP-final, Suffix-Medial), Condition (Total, NV, V) and Speakers (KH, SH, HJ, CD, KS, PS, IK, KJ, IP, LJ, OS, and LH) served as within-participant factors. The analysis revealed that there were significant effects of the P-Category [$F(1,24)=440.56$, $p<.001$], Condition [$F(2,48)=28.72$, $p<.001$], and Speaker [$F(11,264)=51.16$, $p<.001$], as well as significant interactions of the P-Category X Condition [$F(2,48)=6.26$, $p<.05$], P-Category X Speaker [$F(11,264)=60.96$, $p<.001$], Condition X Speaker [$F(22,528)=2.36$, $p<.05$], and P-Category X Condition X Speaker [$F(22,528)=2.99$, $p<.001$].

Table 1. Correct responses (%) (with standard deviations) for the alveolar nasal in Korean for each speaker across the three stimulus conditions in the IP position

SP	IP		
	Total	NV	V
KH(F)	100(.00)	100(.00)	80(40.82)
SH(F)	100(.00)	100(.00)	80(40.82)
HJ(F)	100(.00)	100(.00)	64(48.99)
CD(F)	96(20.00)	100(.00)	96(20.00)
KS(F)	96(20.00)	100(.00)	96(20.00)
PS(F)	96(20.00)	100(.00)	92(27.69)
IK(M)	100(.00)	100(.00)	88(33.17)
KJ(M)	88(33.17)	100(.00)	100(.00)
IP(M)	96(20.00)	100(.00)	80(40.82)
LJ(M)	100(.00)	100(.00)	100(.00)
OS(M)	100(.00)	100(.00)	96(20.00)
LH(M)	96(20.00)	96(20.00)	96(20.00)
Means	97.3	99.7	89

*SP=speaker, IP=IP-final, Total=Total condition, NV=NV condition V=V condition, F=female, M=male

*Means are based on a total of the responses for 12 speakers per category.

Table 2. Correct responses (%) (with standard deviations) for the alveolar nasal in Korean for each speaker across the three stimulus conditions in the SM position

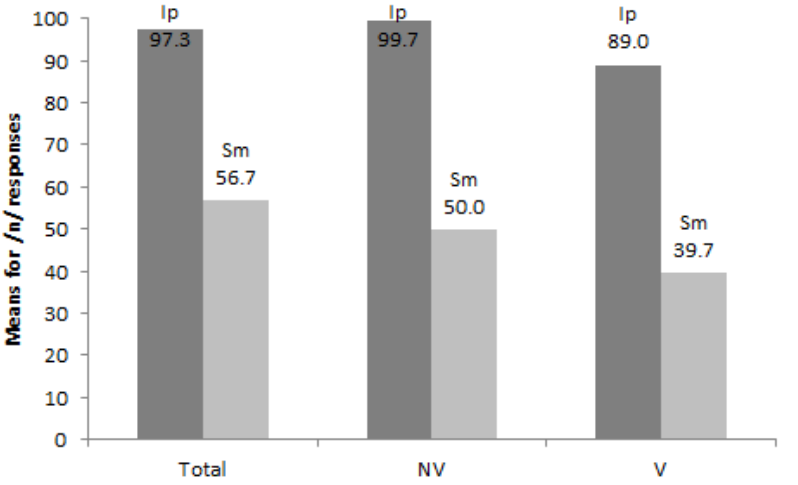
SP	SM		
	Total	NV	V
KH(F)	88(33.17)	96(20.00)	80(40.82)
SH(F)	8(27.69)	0(.00)	0(.00)
HJ(F)	76(43.59)	88(33.17)	68(47.61)
CD(F)	48(50.99)	0(.00)	0(.00)
KS(F)	88(33.17)	96(20.00)	68(47.61)
PS(F)	80(40.82)	84(37.42)	52(50.99)
IK(M)	88(33.17)	68(47.61)	68(47.61)
KJ(M)	12(33.17)	0(.00)	0(.00)
IP(M)	84(37.42)	64(48.99)	60(50.00)
LJ(M)	8(27.69)	16(37.42)	20(40.82)
OS(M)	16(37.42)	8(27.69)	0(.00)
LH(M)	84(37.42)	80(40.82)	60(50.00)
Means	56.7	50	39.7

*SP=speaker, SM=Suffix-medial, Total=Total condition, NV=NV condition V=V condition, F=female, M=male

*Means are based on a total of the responses for 12 speakers per category.

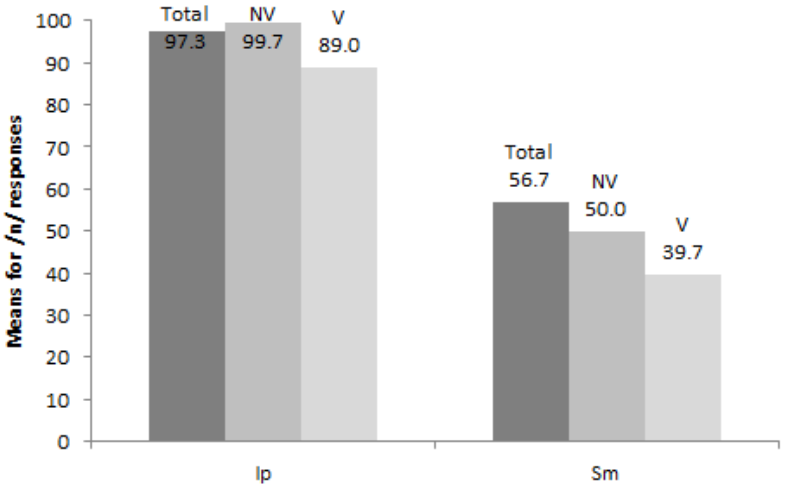
Post-hoc tests revealed that in each condition (Total, NV, V), the stimuli *-ni* in the IP-final position showed significantly more alveolar nasal responses than those in the SM position ([p < .001 for all conditions]). Specifically, the alveolar nasal responses for the stimuli of the IP-final position vs. SM position are 89% vs. 39.7% in the V condition, 99.7% vs. 50% in the NV condition, and 97.3% vs. 56.7% in the Total condition, respectively, as is shown in Figure 1.

Figure 1. Responses (%) of [n] in each condition



In each P-category, significant differences in the perception of alveolar nasal were observed between conditions as is shown in Figure 2. Within the IP-final category, the stimuli in the V condition showed fewer alveolar nasal responses than those in the NV condition [p < .001] and Total condition [p < .05]. There was no significant difference in the perception of alveolar nasal between the NV condition stimuli and Total condition stimuli [p =.209]. Within the SM category, the V condition stimuli showed significantly fewer alveolar nasal responses than the NV Condition stimuli [p < .05] and Total Condition stimuli [p < .001]. The NV Condition stimuli showed fewer correct alveolar nasal responses than the Total condition stimuli [p < .05].

Figure 2. Responses (%) of [n] in each P-category



In summary, the stimuli from the SM boundary showed significantly fewer alveolar nasal responses (more errors) than those from the IP-final boundary. In addition, the stimuli in the V-condition showed significantly fewer alveolar nasal responses (more errors) than those in the NV and Total conditions in both P-categories, and the stimuli in the NV condition showed significantly fewer alveolar nasal responses (more errors) than those in the Total condition in the SM category.

Post-hoc tests also revealed that significant effects of the speakers were observed on the SM-category X Condition but not on IP-final category X Condition.

SM category and Total condition: The stimuli produced by four speakers, SH, KJ, LJ, and OS, showed significantly fewer alveolar nasal responses than those by seven speakers, KH, HJ, KS, PS, IK, IP, and LH ([p < .001] for any two members, one from the former group and the other from the latter group). The stimulus by speaker CD showed significantly more alveolar nasal responses compared to that by speaker SH ([p < .05]), but showed no significant difference in alveolar nasal responses from that by all of the other speakers (KJ [p = .276], OS [p = 1.000], LJ [p = .324], KH [p = .133], HJ [p = 1.000], KS [p = .324], PS [p = 1.000], IK [p = .133], IP [p = .622], LH [p = .276]).

SM category and NV condition: The stimuli produced by four speakers, SH, KJ, OS, and CD, showed significantly fewer alveolar nasal responses than those produced by seven other speakers, KH, HJ, KS, PS, IK, LH, and IP ([p< .001] for any two members, one from the former group and the other from the latter group except between OS and IP [p < .05]). The stimulus by speaker LJ, however, showed no significant difference in the perception of alveolar nasal, not only from the stimulus by speakers SH [p =1.000], CD [p =1.000], KJ [p =1.000], and OS [p =1.000] but also from the stimulus by IP [p = .079]. However, it showed significant differences from the stimulus by KH ([p < .001]), HJ ([p < .001]), KS ([p < .001]), PS ([p < .001]), IK ([p < .05]), and LH ([p < .001]).

SM category and V condition. The stimuli produced by four speakers, SH, KJ, OS, and CD, showed significantly fewer alveolar nasal responses than the ones produced by KH, HJ, KS, PS, IK, and LH ([p < .001] for any two members, one from each group except PS and any member of the former group [p< .05]). Stimulus by speaker LJ, however, showed a significant difference in the perception of the alveolar nasal from that by speakers KH [p < .001], HJ [p < .05], and IK [p< .05], but no significant difference from that by speakers SH [p = 1.000], KJ [p = 1.000], OS [p = 1.000], CD [p = 1.000], KS [p = .079], PS [p = .552], IP [p = .133], and LH [p= .613].

In summary, the results showed that there were two groups of speakers (SH, KJ, and OS vs. KH, HJ, IK, KS, PS, and LH) and the stimuli of one group induced significantly different alveolar nasal responses from those of the other group in each and every condition. In addition, the alveolar nasal responses induced by the stimuli of three speakers, CD, LJ and IP, did not belong to either group consistently in all conditions.

2.5. Discussion

The results of this experiment showed that a high pitched *-ni* syllable occurring at the higher prosodic domain boundary IP showed significantly more alveolar nasal responses (fewer errors) than the corresponding *-ni* syllable occurring in the middle of the suffix with L tone in the V condition (89% vs. 39.7%), the NV condition (99.7% vs. 50%), and the Total conditions (97.3% vs. 56.7%).

The perceptual results answer one of the questions we raised in Introduction: the [ni] sequence at the prominent IP-final position with a prominent H tone is more resistant to perceptual confusion than the other [ni] sequence in the suffix-medial position with L tone.

Another interesting result in this experiment showed that the alveolar responses of one group of the speakers (SH, KJ, and OS) were significantly fewer (more errors) than those of the other group (KH, HJ, IK, KS, PS, and LH) in each and every condition. In addition, there are three speakers, CD, LJ and IP, whose alvelar nasal responses to the stimuli in each condition did not belong to either of these groups consistently.

Specifically, a close inspection of the results in the NV and Total conditions of suffix medial *-ni* stimuli showed that there were two groups at the ends in the scale of the correct identification scores: in NV and Total conditions, the stimuli by three speakers, SH, KJ, and OS, induced significantly fewer alveolar nasal responses than those by six speakers, KH, HJ, IK, KS, PS, and LH: 2.7% vs. 85.3% in the NV condition and 12% vs. 84% in the Total condition.

This leads to the speculation that the alveolar nasal [n]s produced by Speakers SH, KJ, and OS may have undergone a near-complete place assimilation to the preceding [m] in *-hamnita,* whereas those produced by Speakers KH, HJ, IK, KS, PS, and LH have not undergone much place assimilation.

Unlike the speakers in these two groups, the stimuli by three speakers, CD, LJ and IP, showed variations in the perception of alveolar nasal depending on the condition types. The stimuli by speaker CD are particularly interesting. When *-nita* stimulus in the NV condition was presented, the alveolar nasal response was 0%, but when *-hamnita* stimulus in the Total condition was presented, the alveolar nasal responses substantially increased to 48%.

We suggest that this is due to the considerably but not completely assimilated nasal murmur [n] to the preceding nasal [m] in *-hamnita* for Speaker CD. When the murmur was presented as the first segment, *-nita* in the NV condition, it was perceived as [m] due to its considerably assimilated place features. When the full murmur including the transition portion from the preceding [m] to [n] was presented in the middle of the stimulus in the Total condition, the responses as [n] increased to 48%. We suggest that when

considerably but not completely assimilated murmur [n], produced by CD, is placed next to the prototypical [m] in the Total stimulus as in *-hamnita*, the unchanged features of murmur [n] may become quite contrastive and thus induce 48% of alveolar responses. The results show then that there is great variation in the perception of [n] before [i] among speakers.

Finally, we note one interesting fact observed in the responses of V stimuli in the suffix-medial position. Though the [ni] sequences in this paper occurred in a different phonological environment than that in English (cf. [amni] in Korean vs. #[ni] in English), the V stimuli from Korean suffix-medial *-ni* sequence induced somewhat similar alveolar nasal responses to the V stimuli from the English *-ni* sequence: (39.7% in Korean vs. 31% in English long vowel stimulus). We speculate that when the (murmur truncated) vowel [i] was presented alone as a stimulus, the confusion of [n] to [m] may occur across languages[1)].

Further research is needed to investigate what features underwent assimilation, and what features did not, and how these changed and unchanged features contribute to the perception of place of articulation.

3. Conclusion

Given that [n] was frequently confused as [m] in the perception of various portions of the English *-ni* sequence (cf. Kurowsky & Blumstein, 1984), this paper investigated whether similar perceptual confusion occurred on the corresponding portions of Korean *-ni* sequences. Furthermore, this paper investigated whether the confusion of [n] as [m] was influenced by the prosodic domain boundary and a linguistic factor, pitch, by examining the perception of

1) Kang (2015) reports the perception test results of [n] in the environment of [i e o u] after [am] sequence. The stimuli were /-hamnita/, /-hamneta/, /-hamnota/, and /-hamnuta/, taken from the sentences, *uri motunin 'aka' Tara hamnVta* "We act following 'aka'", in which V represents vowels [i e o u]. Only the suffix *-mnita* is a legitimate suffix and the other suffixes, *-mneta, -mnota,* and *-mnuta* are nonce suffixes. Twelve speakers produced the sentences and thirty listeners participated in the perception test. The test results show that [n] is confused for [m] significantly more in the order of [i] > [e] > [o u] similar to the [n] in English.

two *-ni* sequences with different prosodic features: one occurring in the middle of a suffix *-mnita*: 'stative suffix' with L tone and the other occurring at the IP-final position with H tone, monosyllable suffix *-ni*: 'question marker'. The factor, Speaker, was also investigated to examine whether significantly different perception scores occurred as a function of speakers and, if so, what the range of variations in perception scores was.

The results of the experiment confirmed that the [ni] sequence with H tone occurring at the higher prosodic domain IP boundary showed significantly more alveolar nasal responses (fewer errors) than the [ni] sequence with L tone occurring in the middle of the suffix. The results support the argument that sound segments occurring in more prominent position such as IP-final and with a H tone are more resistant to the confusion than the sound segments occurring in the less prominent position.

The perceptual results also showed that significantly different perception scores occurred as a function of speakers. In the NV and Total conditions, the suffix-medial [n]s produced by some speakers were mostly perceived as [m] (cf. near categorical change) while those produced by some other speakers did not show many [m] responses. Still some suffix-medial [n]s produced by other speakers showed variations in the perception responses depending on the stimuli condition.

Ohala (1993) argues that confusion of a sound leads to variations in perception and that variations in perception leads to sound change. In Argentine Spanish, a sound change was reported in which [s] was changed to [h] at different rates when placed at two different prosodic positions, the position before a C and the position at the end of the word before another vowel (cf. Bybee, 2000). This paper reported that the [ni] sequences from two Korean suffixes showed different perception results of place of articulation. As most suffix-medial [ni] sequences of some speakers seem to show near-complete assimilation to the preceding [m] and become [mi], we suspect that sound change from the suffix-medial [n] to [m] in the /(a)m__i/ environment may be currently taking place for these speakers. Whether this variation for [ni] sequences becomes a stable phonological rule and stays in Korean phonology needs to be reinvestigated in the future.

Finally, the results of this perception test offer some insights into the

understanding of place assimilation in Korean. As we noted in section 1, Korean is known to have only regressive place assimilation. However, the perceptual results in this paper show that when the [ni] sequence occurs after another nasal [m] suffix-medially, near-categorical place assimilation from [n] to [m] seems to occur for some speakers. Steriade (2001) argued that the direction of phonological processes depends on the perceptual prominence of the segments involved rather than the syllabic position in which the segments occur. If the onset consonant shows less perceptual prominence than the coda consonant, it is the onset that becomes the target of the assimilation. The results in this paper support the arguments in Steriade (2001): Since an onset [n] in the environment of /am___i/ is less salient than the [m] in the coda position, onset [n] undergoes the progressive assimilation process and becomes [m].

That [n] before a high vowel vocoid can be the target of the phonological rule in Korean is also observed in Kang (2016). Kang (2016) argues that in the (Sino-)Korean nouns, [n] is often deleted before a high vocoid [i j] if the preceding segment is a nasal (e.g. /sam-lju/ --> [sam.nju]~[sam.ju]: 'third grade').

The result in this paper adds one more element of evidence to Kang (2016) that an onset [n] is non-salient in the environment of /nasal__i/ and thus becomes the target of phonological processes such as assimilation or deletion in Korean.

Conclusively, this paper showed that two *-ni* sequences in Korean suffixes showed different perception results of place of articulation due to a different prosodic boundary and a linguistic factor, pitch. Furthermore, the results showed that [n] in the environment of /(a)m___i/ might be undergoing a categorical change for some speakers, arguing for possible sound change in Korean.

References

Bybee, J. (2000). Lexicalization of sound change and alternating environments. In M. Broe & J. Pierrehumbert (Eds.), *Papers in laboratory phonology* (pp. 250-268). Cambridge: Cambridge University Press.

Cho, T. (2016). Prosodic boundary strengthening in the phonetics-prosody interface. *Language and Linguistics Compass,* 10(3), 120-141.

Hillenbrand, J. (1984). Speech perception by infants: Categorization based on nasal consonant place of articulation. *Journal of the Acoustical Society of America,* 75, 1613-1622.

Kang, H. (2015). *An argument for cue-based theory in Korean: Progressive assimilation and deletion.* Paper presented at 2015 ICKL & Harvard-ISOKL, Chicago, Illinois, 24-27, July.

Kang, H. (2016). Perceptual deletion of onset /n/ in Korean. *The Linguistic Association of Korea Journal,* 24(3), 1-16.

Krivokapić, J. & Byrd, D. (2012). Prosodic boundary strength: An articulatory and perceptual study. *Journal of Phonetics,* 40(3), 430-442.

Kurowski, K. & Blumstein, S. (1984). Perceptual integration of the murmur and formant transitions for place of articulation in nasal consonants. *Journal of the Acoustical Society of America,* 76, 383-390.

Ladefoged, P. & Johnson, K. (2015). *A course in phonetics.* Stanford: Cengage Learning.

Liberman, A., Delattre, P., Cooper, F., & Gerstman, L. (1954). The role of consonant-vowel transitions in the perception of the stop and nasal consonants. *Psychol. Mono.,* 68, 1-13.

Malécot, A. (1956). Acoustic cues for nasal consonants: An experimental study involving a tape-splicing technique. *Language,* 32, 274-284.

Ohala, J. (1985). Linguistic and automatic processing of speech. In R. De Mori & C. Suen (Eds.), *New systems and architectures for automatic speech recognition and synthesis* (pp. 447-475). Berlin: Springer-Verlag.

Ohala, J. (1993). The phonetics of sound change. In C. Jones (Ed.), *Historical linguistics: problems and perspectives* (pp. 237-278). London: Longman.

Repp. B. (1986). Perception of the [m]-[n] distinction in CV syllables. *Journal of the Acoustical Society of America,* 79, 1987-1999.

Recasens, D. (1983). Place cues for nasal consonants with special reference to Catalan. *Journal of the Acoustical Society of America,* 73, 1346-1353.

Steriade, D. (2001). Directional asymmetries in place assimilation: a perceptual account. In E. Hume & K. Johnson (Eds.), *The role of speech perception in phonology* (pp. 219-250). San Diego, CA: Academic Press.

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