On Korean Fricatives

Kyung-Shim Kang*

ABSTRACT

Although Korean stops and affricates show a three-way contrast of phonemes into lax, tense and aspirated, Korean fricatives have only two types, so-called 'lax' and tense. Considering that all the other obstruents maintain a three-way distinction but fricatives, it might be interesting to investigate whether the lax fricatives are really 'lax' in their phonetic and phonological realizations, as assumed. From an acoustic analysis, I found that Korean lax fricatives had a heavy aspiration along with a high pitch for the following vowel, being more comparable to the aspirated category. By contrast, their durational properties were found to be short, or lax-like. In other words, Korean lax fricatives are phonetically neither lax nor aspirated, but both. This dual nature of the lax fricatives takes a better account of the fact that why lax fricatives are subject to tensification, but not aspiration phonologically. Is that simply because there is no aspirated fricative in Korean? I suggest that Korean lax fricatives undergo tensification because of their being short in duration, and that they are not subject to the aspiration rule because they are indeed aspirated sounds.

Keywords : lax fricative, tense fricative, aspiration, tensification

1. Introduction

A great deal of attention has been paid to describing the phonetic and phonological characteristics of the Korean stops, as they show a complicated, three-way contrast. In contrast, previous studies on Korean fricatives have been scarce both in quantity and quality. As the fricatives allow only a two-way contrast, assigning them to appropriate categories of the obstruent system has been an interesting agenda.

There have been no disagreements on the status of the tense fricatives, for their phonetic and phonological features go perfectly with those of the tense stops and affricates. However, for the so-called lax fricatives, an early phonetic study by Kagaya (1974) labelled them as 'aspirated' due to their longer VOT lag than the lax stop category, whereas most Korean linguists categorized them as 'lax'. Especially, Iverson

* Busan College of Information Technology.

(1983) noted that the Korean 's' had an intermediate level of VOT in Kagaya's (1974) report, being longer than the typical lax category but shorter than the aspirated, and he claimed that 's' shares laryngeal features with both the lax and aspirated series but that its phonological assignment is to the lax category. In details, he suggested that 's' has laryngeal features [-stiff glottis] shared with the lax and [+spread glottis] with the aspirated. Besides, as the further evidence of its being lax, he asserted that the Korean 's' undergoes not only the intersonorant 'slackening' process (see also Kim-Renaud 1974) but also the tensification rule, applied only to the lax series.

Considering that few attempts have been made to characterize the phonetics of the Korean fricatives in comparison with their alveolar stops, it is worthwhile to investigate some of the important phonetic properties of the fricatives and to compare the results with their stop counterparts. Furthermore, Iverson's (1983) claim on the phonological status of the Korean 's' seems more likely to be based on his own (or traditional) speculations rather than being phonetically precise accounts. To achieve a certain degree of phonetic accuracy, it is necessary to reconsider what mechanisms such phonological processes as aspiration and tensification have and whether their operation needs to be restricted to a certain category, thus automatically determining the categorization.

2. Acoustic study

The focus of the investigation lies on the crucial issue of how to characterize the acoustic properties of the Korean fricatives' VOT, duration, and Fo, and their roles in maintaining the two-way distinctions in the obstruent system of Korean which basically contrasts in three ways. In order to assess the phonetic characteristics of fricatives properly, I compared them with those of alveolar stops.

The test words subject to acoustic analysis contained all the different types of fricatives and alveolar stops that showed a contrast either word-initially or word-medially, as in (1) and (2).

(1) Minimal pair words for the fricatives

a. word-initially		b. word-medially
/sa.ta/	'to buy'	/pa.sak/(onomatopoeia)
/s'a.ta/	'cheap'	/pa.s'ak/(onomatopoeia)

(2) Minimal pair words for the alveolar stops

a. word-initially		b. word-medially
/te.u.ta/	'to warm up'	/sa.to/'evil way'
/t'ae.u.ta/	'to manage'	/sa.t'o/'mayor (archaic)'
/t^hae.u.ta/	'to burn up'	/sa.t^ho/'sandy soil'

All the test words[1] were produced in isolation by native speakers of Korean. Two male and female speakers participated in this study, and they read out the words written on 5×3 cards that were shuffled randomly. Each word was repeated three times by four native speakers, so that the total of the tokens produced for the fricatives and alveolar stops was 120. Each subject was recorded in a sound-treated room using a SONY TCM-API V recorder and Optimus microphone.

The acoustic analyses of the tokens were achieved through SoundScope (GW Instruments, Somerville, MA). The SoundScope renders spectrograms, waveforms and Fo contours on a spaciotemporal dimension, making it plausible to measure the VOT, duration and Fo of each token.

For statistical analyses, I used the Statview 5.0 and SuperANOVA programs. Repeated Measures ANOVAs were conducted for the acoustic data gathered for the fricatives and alveolar stops.

2.1 VOT

For fricatives, VOT was interpreted as the temporal duration between the onset of aspiration around the end portion of frication and the voice-onset of the following vowel. The onset of aspiration was taken to be the point where the higher frequency turbulence became attenuated, and lower intensity random striations appeared in the lower frequencies, especially in the ranges reflecting the frequencies of the formants of the following vowels.

For alveolar stops, VOT was regarded as the temporal measure between the onset of stop release and the voice-onset of the following vowels.

The mean VOT values of the Korean fricatives and alveolar stops are listed in Table 1.

Table 1. The mean VOT values of the Korean fricatives and alveolar stops produced by four native speakers in word-initial and -medial positions; in milliseconds; 24 tokens per phoneme.

	Fricatives		Alveolar Stops		
	Tense	Lax	Tense	Lax	Aspirated
w-intial	21	77	21	55	82
w-medial	24	53	16	20	78

1) Although the first vowels of the minimal pairs contrasting alveolar stops initially have phonemically different forms of /e/ and /ae/, they are claimed to be merged to the point that few native speakers distinguish the two vowels in their production and perception (Hong 1987, Lee and Zhi 1987).

Tense fricatives were almost identical to tense alveolar stops not only in the sense that they had the shortest VOT among the series but also in that their mean VOT values were almost identical to each other. The mean VOTs of lax fricatives, however, were found to be intermediate, being much longer than those of lax alveolars but slightly shorter than aspirated ones, especially in word-initial position. It is also notable that in word-medial position, lax fricatives had a mean of 53 ms of VOT, twice longer than tense fricatives. In contrast, medial lax stops had a mean 20 ms VOT, almost the same as their tense counterparts due to some of the tokens that started with a voiced allophone. This difference resulted from the fact that lax fricatives did not undergo voicing alternation in word-medial or intervocalic position, whereas lax stops did. Thus, these two facts strongly suggest that lax fricatives are more comparable to aspirated stops than to lax ones with respect to the VOT parameter.

For statistical analyses, I computed means for every subject with phonation type (Type) and word-position (Position) as the within-subject factors. Repeated Measures ANOVAs on the fricative measurements revealed that there was a significant effect for phonation type [$F(1,16)=52.853$, $p<0.01$], indicating that the speakers differed in terms of their average VOT for lax vs. tense fricatives. VOT differences by the function of word-position turned out to be statistically insignificant [$F(1,16)=3.996$, $p>0.13$]. There were also no significant Position x Type interactions [$F(1,16)=7.637$, $p>0.06$]. In the case of alveolar stops, there was also a significant effect for phonation type [$F(2,24)=84.169$, $p<0.0001$]. VOT variations by word position among the three stop series turned out to be significant [$F(1,24)=14.060$, $p=0.0331$], indicating VOT varies to a great extent relative to the position in a word. However, there was no significant interactions between phonation type and position [$F(2,24)=4.478$, $p>0.06$]. Separate. statistics between each two stop categories in the same position indicated that there were significant VOT differences by the function of phonation type between lax and aspirated types and between tense and aspirated types, with p-values under <0.01, irrespective of the position where they occurred. However, VOT differences between the medial lax and tense were insignificant [$F(1,8)=2.773$, $p=0.1945$], indicating the VOT values between the two types were almost identical in the word-medial position, .as predicted.

2.2 Duration

The duration of the fricatives and alveolar stops was measured based on spectrograms and waveforms obtained by SoundScope. Since fricatives do not involve a closure duration, I excluded closure duration measurements and included only total durations. For fricatives, total duration was interpreted to mean the sum of frication and aspiration, but for alveolar stops, it was meant to be the sum of closure and aspiration. Total durations were measured both word-initially and -medially for fricatives, whereas

those of alveolar stops were limited to word-medial positions, as stop closure durations were not available in initial position.

The duration of vowels following as well as preceding the alveolar segments was also measured through spectrograms and waveforms. Vowel duration was regarded as the temporal distance from the voice onset of a vowel to the offset of the first formant of the vowel.

The result of the mean total durations for the fricatives and alveolar stops is given in Table 2.

Table 2. The mean total durational values of the Korean fricatives and alveolar stops produced by four native speakers in word-initial and -medial positions; in milliseconds.

	Fricatives		Alveolar Stops		
	Lax	Tense	Lax	Tense	Aspirated
w-intial	138	161			
w-medial	91	167	85	221	219

The average total duration for lax fricatives was 138 ms word-initially and 91 ms word-medially, while that for tense fricatives was 161 ms and 167, respectively. The mean total durational difference between the two types was observed to be as large as 76 ms when located in word-medial position.

In the case of alveolar stops, the mean total durations for the tense and aspirated series were virtually identical, making little differences between the two categories. However, the mean durational difference between lax stops and either of tense and aspirated stops was so large that total duration measurements drew a binary contrast between the lax and the remaining categories. Therefore, that the lax fricatives had much shorter total durations than tense counterparts implied that the former functions as a typical lax with respect to total duration.

Statistical results showed that there was a significant effect on phonation type for the fricatives ($p<0.05$). When separately conducted in each position, statistics revealed a significant function for phonation type not word-initially ($p>0.33$) but medially ($p<0.001$). Besides, no significant effects on total durations were found in terms of word position and interactions between Type and Position.

A statistical analysis of the stop series revealed that there was a significant total durational difference among the three stop series ($p<0.0001$), but that of each two stop categories indicated that there were no significant durational differences between tense and aspirated stops ($p=0.9076$), while lax stops varied significantly from tense and aspirated ones in total duration. Thus, in medial position, lax fricatives whose average

total duration varied significantly from tense counterparts seem to behave in the same way as lax stops.

Turning to vowel durations, the mean durations of the vowel following as well as preceding the fricatives and alveolar stops are listed in Table 3.

Table 3. The mean durational values of the vowel following as well as preceding Korean fricatives and alveolar stops produced by four native speakers in word-initial and -medial positions; in milliseconds.

		Fricatives		Alveolar Stops		
		Lax	Tense	Lax	Tense	Aspirated
following v.	w-initial	97	146	193	158	115
	w-medial	154	161	120	109	88
preceding v.	w-medial	107	80	136	86	87

The vowels following a lax fricative were found to be much shorter than those after a tense fricative in initial position but almost analogous in medial position. What was worth mentioning was that the mean durational difference of the vowels following lax vs. tense fricatives was as large as 49 ms in initial position. In contrast, the duration of the vowels following alveolar stops was found to be the longest after a lax, of medium length after a tense, and the shortest after an aspirated. Thus, vowels after a lax stop were much longer than after a tense, while the durational pattern became reversed when the vowels followed fricatives. This indicates that the durational pattern of the vowels following Korean lax fricatives is more equivalent to that after aspirated alveolars than after lax ones in initial position but not medially.

Statistics showed that vowels following a lax fricative were significantly shorter than those after a tense [$F(1,16)=361.462$, $p<0.001$]. However, there was no significant effect for word position [$F(1,16)=6.596$, $p>0.08$], implying vowel durational variation as a function of word position was consistent. Nevertheless, a significant effect for Position x Type interactions was observed for vowel durations after fricatives [$F(1,16)=23.303$, $p<0.05$], which implies that vowel durational differences by phonation type might get affected by word position the vowel occurs. In fact, there was a significant durational difference by phonation type when the vowel following fricatives was in initial position [$F(1,16)=72.768$, $p<0.01$], but not in medial position [$F(1,16)=6.350$, $p>0.08$].

In the case of alveolar stops, it was found that there was a significant effect by the functions of phonation type [$F(2,24)=14.996$, $p=0.0046$] and word position [$F(1,24)=211.685$, $p=0.0007$]. However, there was no significant effect by the interaction between the type and position [$F(2,24)=0.879$, $p=0.4627$]. Statistics across each two stop categories revealed that vowels following lax or tense stops were significantly longer than those after

aspirated stops ($p<0.05$), but that those after lax stops were not any longer than those following tense stops ($p=0.1979$). Thus, lax fricatives in medial position affect the duration of the following vowel in the same way that lax stops do.

On the other hand, vowels preceding lax fricatives in medial position were found to be longer than those before tense fricatives. The mean difference of the vowels preceding a lax /s/ and tense /s'/ was 27 ms. In a similar way, vowels preceding lax alveolar stops were much longer than those preceding tense alveolars, with a mean difference of 50 ms. Although the mean durational difference of the two fricative types was relatively small, statistics showed that durations of the preceding vowel were significantly different depending on the type of the fricative that came right after the vowel [$F(1,16)=65.466$, $p<0.01$].

When the vowel preceded an alveolar stop, its duration was found to be significantly different relative to the phonation type of the stop [$F(2,24)=8.171$, $p=0.0194$]. Between the lax and tense types, vowels preceding a lax were significantly longer than those before a tense ($p=0.0462$), which in turn were almost as long as those preceding an aspirated ($p=0.8278$). Thus, the fact that the vowel preceding a lax fricative was significantly longer than before a tense fricative corroborates that the lax fricative /s/ behaves much in line with the lax stop with regard to the duration factor.

2.3 Fo

Fundamental frequencies at the voice onset of the following vowel were measured using the peak-picking method on SoundScope. When the Fo value at the voice onset was not available for some reasons, I measured the initial point of the Fo contour, of which the distance from the voice onset was usually less than 10 to 15 ms.

The mean Fo onset values of the vowel following fricatives and alveolar stops are given in Table 4.

Table 4. Mean Fo onset values of the vowel following Korean fricatives and alveolar stops produced by the four native speakers in word-initial and -medial positions; in hertz.

	Fricatives		Alveolar Stops		
	Lax	Tense	Lax	Tense	Aspirated
w-intial	227	220	192	227	248
w-medial	192	189	193	190	206

Mean Fo onset values of the following vowels were slightly higher when they came after lax fricatives than tense ones both in initial and medial positions. In contrast, mean Fo onset values were found to be the lowest after initial lax alveolar stops. In initial

position, mean Fo differences between the lax and the other stop categories were over 30 hertz. However, in medial position, Fo differences among the three stop series were such reduced that the Fo differences between any two categories were either 16 hertz or less. Thus, if we focus on the Fo differences in word-initial position only, it can be said that mean Fo values after lax fricatives are similar to those after aspirated alveolar stops, rather than lax ones.

Repeated Measures ANOVAs indicated that there was no significant difference between the Fo values at the onset of vowels following lax fricatives compared to tense fricatives ($p=0.2139$). There was also no significant effect on the Fo onset values in terms of word-position ($p=0.2238$). However, a statistical analysis of Fo onset values of the vowels following a stop indicated that there was a significant effect by the function of phonation type [$F(2,18)=8.258$, $p=0.0380$], whereas word position did not cause any significant variations on Fos [$F(1,18)=0.359$, $p=0.0923$]. The interactions between phonation type and word position were also found to be insignificant [$F(2,18)=6.225$, $p=0.0591$]. Separate ANOVAs comparing each two categories in the same position revealed that Fo values of the vowel following a lax stop were significantly lower than those after a tense ($p=0.05$) in initial position. However, in medial position, Fos of the vowel following a lax stop were not significantly lower than those after a tense or aspirated, with p-values over >0.05.

2.4 Summary

In sum, Korean fricatives and alveolar stops are found to have the following characteristics, as in Table 5. As seen in Table 5, the tense fricatives have all the same phonetic properties as tense alveolar stops, whereas the lax fricatives show a mixture of lax and aspirated-like characteristics. In terms of VOT and Fo, lax fricatives behave like aspirated stops, as their heavy aspiration influences not only the VOT dimension but the Fo onset of the following vowel. However, with respect to duration, lax fricatives exhibit dual properties as both the lax and aspirated series relative to the position in which they occur. That is, the duration properties of /s/ are in line with aspirated stops initially, but with lax ones medially. Although /s/ reflects aspirated-like durational characteristics initially, it might be the case that the lax fricative has lax-like durational properties, but that its heavy aspiration might affect the durations to be more compatible with the aspirated series in initial position. On the contrary, in medial position, /s/'s total duration is reduced greatly, which in turn causes the following vowel to undergo a compensatory lengthening. Therefore, I hypothesize that the lax fricative is an aspirated consonant by the phonetic criteria of VOT and Fo, but that it is a lax in terms of the duration parameter.

Table 5. A summary of phonetic characteristics of Korean fricatives and alveolar stops; word-initial/word-medial.

		Fricatives		Alveolar Stops		
		Lax	Tense	Lax	Tense	Aspirated
VOT		long	short	med/short	short	long
Duration	Total	long/short	long	short	long	long
	Following vowel	short/long	long	long	long	short
	Preceding vowel	long	short	long	short	short
Fo		high	high	low	medium	high

3. Discussion

The current acoustic study has shown that the two fricative series in Korean behave like the aspirated and tense stops with respect to VOT and Fo. /s/'s heavy aspiration reinforces the hypothesis that the segment traditionally considered a lax in fact has more in common with aspirated stops, i.e. the aspirated series in general, in terms of VOT. However, durational properties associated with /s/ are more similar to the lax category rather than the aspirated. For instance, in word-initial position, where VOT properties are maximized, duration of the following vowel was significantly shorter than the vowel after /s'/, in accordance with the pattern of aspirated stops. However, in word-medial position, where VOT values are reduced and durational values are maximized, duration of the vowel following /s/ was almost as long as the vowel after /s'/, acting like the lax series. Furthermore, vowels preceding /s/ are much longer in duration than those before /s'/, complying with those preceding a lax stop.

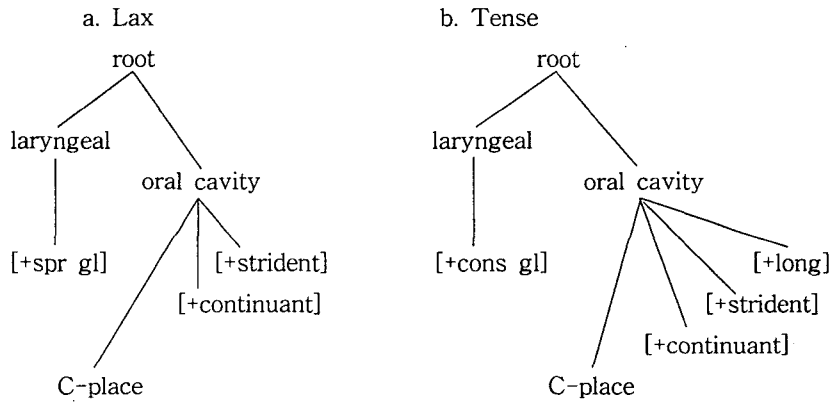
Then, how can we incorporate these phonetic facts of the Korean fricatives into the crucial task of abstracting their phonological representations? A number of Korean linguists have paired the tense and aspirated stop series with the laryngeal features of [+constricted glottis] and [+spread glottis], respectively, while they leave the lax series with no marked laryngeal feature (K-H Kim 1987, Silva 1992, J-I Han 1992, 1996). However, these laryngeal features alone cannot give a full account of the Korean /s/, since the feature [+spread glottis] fails to predict that the aspirated /s/ contains a lax-like, short durational property, distinct from aspirated stops.

Therefore, I propose to use the [long] feature for Korean fricatives as well as stops. One of the reasons to propose such a duration-specific feature is that durational properties of the consonant itself and neighboring vowels serve as an important cue in maintaining a multiple distinction of Korean obstruents and that although it works in line with VOT or glottal features in many cases, durational behavior is not totally subor-

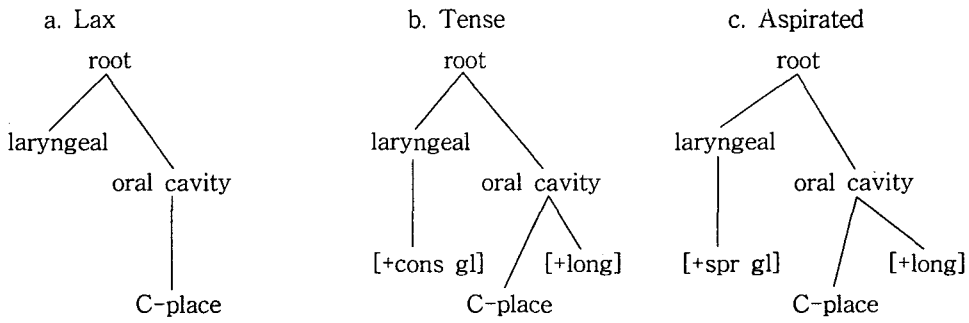
dinate to the glottal mechanism, just as the Korean /s/ demonstrates. By the contrast of the glottal as well as durational features, the Korean /s/ can be characterized as [+spread glottis] and [-long], whereas /s'/ as [+constricted glottis] and [+long]. Similarly, Korean tense stops and affricates are to have the same [+constricted glottis] and [+long] features as tense fricatives. On the other hand, aspirated stops and affricates have [+spread glottis] and [+long] features, whereas lax counterparts lack any of the marked features, and get assigned later with [-] values into [-constricted glottis], [-spread glottis] and [-long] by the default.

If I illustrate structural differences between the two fricative types as well as among the stop series using the feature geometry model by Clements and Hume (1995), the Korean obstruents can be characterized as in (3) and (4).

(3) Underlying phonological representations of the Korean fricatives:



(4) Underlying phonological representations of the Korean stops:



The Clements and Hume's (1995) model reflects the phonetic tradition of representing speech segments in terms of their characteristic constrictions in the oral tract such as

constriction degree and location, as well as laryngeal features (Clements 1991, Hume 1992). Features are organized hierarchically in the model. They are grouped into class nodes such as laryngeal and oral cavity nodes in an intermediate level and finally linked to a root node that corresponds to the speech sound itself.

Using the Clements and Hume's model as the basic format, I align the laryngeal node of /s/ with [+spread glottis] and that of /s'/ with [+constricted glottis]. In the oral cavity node, /s'/ is aligned with [+long], but /s/ lacks such a marked durational feature. Besides, a few marked manner features, i.e. [+strident] and [+continuant], are further linked to the oral cavity nodes to identify the segment as a fricative. In the case of stops, the laryngeal node of tense and aspirated obstruents are assigned with [+constricted glottis] and [+spread glottis], respectively, while the lax series, whose VOT is neither long enough to be labelled as aspirated nor short with the constricted glottis, carries a bare laryngeal node instead. The feature [+long] is also assigned to the oral cavity node of tense and aspirated series only as the lax, whose duration is short, get assigned with [-long] by the redundancy rule, which fills-in empty nodes with features denoting a minus value.

So far, I have attempted to develop idealized segment structures for Korean fricatives on the basis of acoustic analyses comparing the fricatives from the homorganic stops. The cardinal features that I suggest in this paper for the Korean /s/ and /s'/ are [spread glottis], denoting aspiration, and [long], pertinent to durational property. These two distinctive features are also useful in discussing in depth the two well-known phonological processes, i.e. aspiration and tensification.

3.1 Aspiration

When lax stops and affricates immediately precede or follow the glottal consonant /h/, the two sounds are fused into one segment, i.e. an aspirated consonant. For instance, the sequences /ip 'to wear'+hi 'Passive'/, and /tah 'to arrive'+ta 'Declarative'/ are realized as [i.p^{h}i 'to be worn'] and [ta.t^{h}a 'arrive'], respectively.

In the generative framework, B-G Lee (1976) claimed that lax stops and affricates are separated from /h/ by the [-segment] boundary, and that they become aspirated, while /h/ gets deleted. Using a CV skeleton, S-C Ahn (1985) interpreted the aspiration rule as the process that associates the syllable-final segment to the next onset C slot. The sequence of a syllable-final {[+obstruent], [-continuant]} and syllable-initial /h/ or the opposite, i.e. 'mirror image', becomes mapped into a single C slot at syllable-onset.

However, these previous accounts do not explain why the lax fricative alone does not participate in aspiration, while the remaining lax segments do. For example, the alveolar stop /t/ in the sequence /nolah 'yellow'+ta 'Declarative'/ undergoes aspiration as the whole string surfaces as [no.la.t^{h}a 'is yellow']. In contrast, /s/ in /nolah 'yellow'+supnita

'Declarative (polite)'/ is realized as a tense, far from being aspirated, as the whole sequence is pronounced as [no.la.s'umnita 'is yellow]. Is that simply because /s/ is [+continuant], instead of being [-continuant], or is that because there is no aspirated fricative in Korean? I argue that aspiration is the phonological process of adding a feature [+spread glottis] from /h/ to a lax obstruent whose laryngeal node is underspecified, and that /s/ does not undergo aspiration, as its laryngeal node is specified with the feature [+spread glottis] in its underlying representation.

When adjacent to a lax stop or affricate, the glottal sound /h/ becomes reduced into [+spread glottis], which in turn gets inserted under the laryngeal node of the lax obstruent, just as Figure 1 shows.

On the other hand, when /h/ lies adjacent to a lax fricative, aspiration does not occur, as its laryngeal node is already filled-in with the feature [+spread glottis]. Instead, /h/ becomes neutralized into an unreleased sound, and the preceding unreleased sound opens a way for the following /s/ to be tensified, just as the example [no.la.s'umnita 'is yellow'] shows.

3.2 Tensification

Lax obstruents in Korean become their tense counterparts when they follow another obstruent. In this tensification, or Post-Obstruent Tensification, the preceding obstruent becomes unreleased as it is subject to the neutralization rule, applied to any obstruent in coda position. Thus, a sequence of an obstruent plus a lax is realized as an 'unreleased + tensified' one in Korean. For instance, the sequences /..k.c../ and /..p.s../ in the words /hakcang 'dean'/ and /yepse 'postcard'/ are realized as an 'unreleased + tense', since they are pronounced as [hak.c'ang] and [eyp.s'e], respectively.

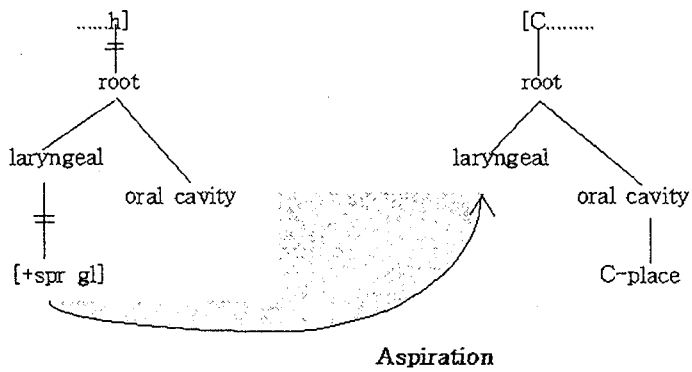


Figure 1. Aspiration (mirror image): Add the feature [+spread glottis] from /h/ to the laryngeal node of a neighboring obstruent with no laryngeal specification.

To explain tensification in generative phonology, Ahn (1985) used the feature [+tense], formulating the rule as [-sonorant] → [+tense] / [-sonorant] __. However, [+tense] were used to group both tense and aspirated consonants in the early generative analyses. Furthermore, the feature [+tense] has not been clearly defined in phonetics. Under a nonlinear and underspecified framework, K-H Kim (1987) and H-S Sohn (1987) claim that lax obstruents in syllable-onset position are changed into their tense counterparts by means of an added feature [+constricted glottis] when they are immediately preceded by a neutralized or unreleased obstruent. More elaborately, Silva (1992) treated the lax stop following an unreleased obstruent as receiving an extra timing slot from the unreleased consonant and the feature [+constricted glottis] by the tensification rule, so that the lax could be realized as its tense counterpart in surface form. However, in Silva's (1992) account, it is not clear how the following lax stop gains an extra timing slot from the preceding obstruent, in case that the preceding obstruent is a lax, linked to one timing slot. Besides, it is not clear why tense obstruents are linked to two timing slots, while aspirated obstruents have only one timing slot, as he argued.

Neither tense nor aspirated obstruents undergo tensification. In other words, the obstruent with the feature [+long] cannot be subject to tensification. Moreover, tensification preconditions the occurrence of neutralization, which prevents the preceding obstruent from releasing and thus provides an extra temporal unit to the following lax, such that the lax, which is originally [-long], might be realized as [+long]. Therefore, I suggest that tensification is the process that assigns the feature [+constricted glottis] to an obstruent, which gains a new length feature [+long] from the preceding unreleased segment.

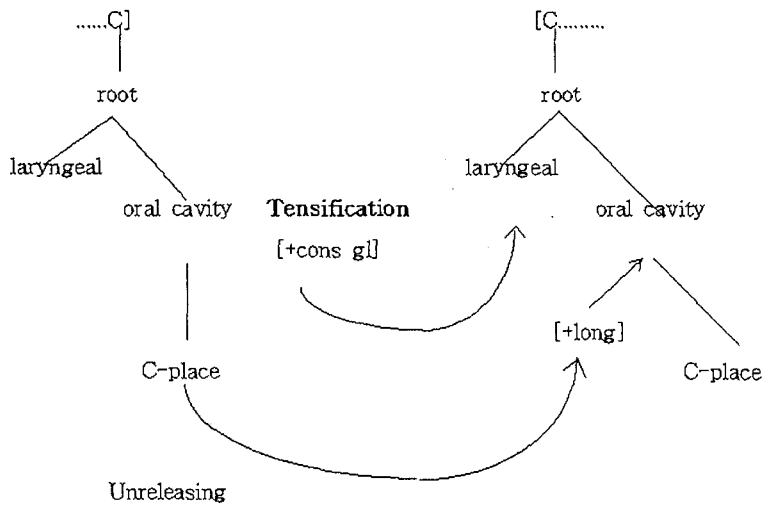


Figure 2. Tensification: Assign the feature [+constricted glottis] to an obstruent, which gains a new length feature [+long] due to the unreleasing or neutralization of the preceding obstruent.

Especially, /s/, which is claimed to be [+spread glottis] but [-long], is also subject to tensification, as it gets aligned with [+long] by the unreleasing of the preceding segment. As soon as it gains the [+long] feature, /s/ is also aligned with a new laryngeal feature [+constricted glottis] by the tensification process, and at the same time /s/'s original feature [+spread glottis] gets deleted as it is incompatible with the new glottal feature.

On the other hand, tense and aspirated obstruents are not subject to tensification, as their length feature is already marked as being [+long], irrespective of the neutralization of the preceding segment.

4. Conclusion

In principle, the Korean /s/ is free to have properties of both lax and aspirated series, since there is no phonemic distinction between the two in the fricatives. However, the Korean lax fricative has more in common with the aspirated category, as the glottis is of large width, causing a heavy aspiration before the vowel onset, and the large amount of airflow causes a high Fo at vowel onset. However, the current study demonstrates that /s/'s durational properties are more in line with lax stops, especially in word-medial position, where its VOT becomes attenuated. In contrast, the tense fricative shows all and only the acoustic properties associated with the tense stops.

Based on the analyses, I propose the lax /s/ contrasts with its tense counterpart by having [+spread glottis] and [-long] features, while the latter employs [+constricted glottis] and [+long] features. What is peculiar in /s/ is that it is heavily aspirated but short in duration unlike stops and affricates that match aspiration with durational properties (see Kang 1999). To put it differently, the so-called lax fricative is in fact a mixture of the lax and aspirated categories by employing the glottal and durational features in a contradictory way. Furthermore, /s/'s dual nature is corroborated by the two phonological processes, i.e. aspiration and tensification. /s/ is not subject to aspiration despite its partial sharing with the lax series, as it is indeed an aspirated sound, and it is tensified after an obstruent despite its carrying a heavy aspiration, as its inherent short duration gets lengthened owing to the preceding unreleased segment, and that initiates the tensification process to be applied to /s/.

So far, I have attempted to assess the phonetic and phonological natures of the Korean fricatives and their status within the obstruent system by comparing them with stop counterparts. Although the hypothesis of /s/'s being [+spread glottis] and [-long] needs further investigation, the current study suggests that /s/ is neither a lax nor an aspirated sound, but both, and that its labeling as a lax be rather arbitrary in certain respect.

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▲ Kyung-Shim Kang
1218 Jinli Hall, Busan College of Information Technology
Goopho 3-dong, Buk-gu, Busan (616-737)
Tel: +82-51-330-7245 (O), +82-51-245-9900 (H)
Fax: +82-51-342-2516
e-mail: kkang@bit.ac.kr