An alternative account of so-called lax consonants with special reference to consonant-tone interaction*

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Kim, Mi-Ryoung. 2000. An alternative account of so-called lax Consonants with special reference to consonant-tone interaction. *Studies in Phonetics, Phonology and Morphology* 6.2, 333-352 In Korean, at the beginning of an accentual phrase, aspirated and tense consonants correlate with a high tone and lax and voiced consonants correlate with a low tone. The correlation has been hard to explain because lax consonants are voiceless initially, yet they pattern with voiced consonants instead of voiceless ones. In this paper, I argue that lax consonants are voiced underlyingly and that the consonant-tone correlation is the familiar voiceless-high and voiced-low. My proposal also offers a simpler way to analyze Korean stops without the feature [tense]. (Korea University)

Keywords: lax, tense, consonant, tone, interaction, tonogenesis

1. Introduction

Recent studies have shown that there is a systematic correlation between onset consonant and tone in Korean (mainly from the investigation of Jeonnam and Seoul Korean)[1]. Specifically, in neutral speech (i.e., excluding extra factors such as vocative chanting or question intonation), if the word initial consonant is voiceless aspirated or voiceless 'tense' (see below), the word has the H(L) pattern, otherwise the word has the LH(L) pattern, where (L) can be regarded as a boundary tone (Gim 1969, 1975, Jun 1993, M.-R. Kim 2000). The domain of such correlation has been called an 'accentual phrase' (Jun 1993), which is usually made of a word or a compound plus its suffixes. In addition, there is some variation with regard to how a tone pattern is realized on a word (e.g. a four-syllable word can be H-H-H-H or H-H-L-L for the H(L) pattern). In this article I will ignore the boundary tone and the variation in tonal realization and focus on the analysis of why a voiceless aspirated or tense consonant correlates with H and why other consonants correlate with LH.

There have been several proposals in the literature but none has been satisfactory. The main difficulty lies in the explanation of the fact that the so-called voiceless lax stops correlate with LH, instead of H as other voiceless consonants do. The fact renders explanations based on

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[1] Following the Romanization of Korean recently revised (December 1999), I use Jeonnam instead of Chonnam, Gwangju for Kwangju, Gyungsang for Kyungsang and so on. It is assumed in this study that other dialects in Korean also have similar effects of consonant-tone interaction, as found in Jeonnam and Seoul Korean.

standard tonogenesis theories inadequate (see below). Because of this, Jun (1993) suggests that Korean tones are underlying or 'phonologized' at the level of intonational phonology. However, the question remains as to why the consonant-tone correlation is fully predictable. Another proposal is that, in addition to the well-known case of F0 perturbation by consonant voicing, Korean presents a new case of F0 perturbation, namely, perturbation by the tenseness (or fortis) of consonants (C.-W. Kim 1965, Gim 1997, Jun 1996). The problem is that there is little evidence for the claim and Korean remains an odd case.

In this study I offer a different analysis. I propose that the so-called lax consonants are underlyingly voiced and that they become devoiced in accentual phrase initial position. The proposal has three advantages. First, it explains why lax consonants are mostly voiced in medial positions whereas aspirated and 'tense' consonants remain voiceless there. Second, it explains why the consonant-tone correlation is what it is--it is the familiar voiceless-high and voiced-low phenomena that characterize tonogenesis. Third, it offers a simpler analysis of Korean consonants, especially the three-way contrast in stops. Instead of requiring three laryngeal features [voice], [aspirated], and [tense] (or [fortis]), two will suffice, [voice] and [aspirated]. The present proposal also has some problems, which will be discussed. However, I believe that overall the present proposal is at least as strong as any other proposal, if not better. Therefore, it is worth serious consideration.

In section 2 I summarize the basic facts of consonant-tone interaction in Korean. In section 3 I review previous analyses. In section 4 I offer the present analysis. In section 5 I discuss further issues. In section 6 I offer conclusions.

2. Basic facts

The effect of consonants on F0 in Korean differs sharply from F0 perturbation by consonant voicing in languages like English and French (Jun 1993, 1996, M.-R. Kim 2000). In the former, the effect can persist through several syllables, whereas in the latter the effect only appears at the beginning of a given syllable. For this reason, the effect in Korean is considered *tonal*, where 'tone' refers to pitch features such as H(high) and L(low), whether such features are used to contrast lexical words, as in Chinese, or to express intonation patterns, as in English. The basic patterns of consonant-tone correlation in Korean are shown in (1) and (2). The boundary tone (L) is ignored. Following the tradition, tense consonants are indicated with an asterisk (e.g. [t*]) and lax stops are written as plain voiceless stops (but see section 4 for an alternative analysis). For clarity, tones on each syllable are separated by a hyphen in (2) (Data cited from M.-R. Kim 2000).

(1) Monosyllables

Words	Gloss	Tone patterns	Tones on syllables
[t^{h}al]	'mask'	H	H
[t*al]	'daughter	H	H
[s^{h}al]	'flesh'	H	H
[s*al]	'rice'	H	H
[tal]	'moon'	LH	LH
[mal]	'horse'	LH	LH
[ɦal]	'egg'	LH	LH

(2) Polysyllables

Words	Gloss	Tonal patterns	Tones on syllables
[p^{h}a:ri]	'fly'	H	H-H
[t*algi]	'strawberry'	H	H-H
[s^{h}at^{h}uri]	'dialect'	H	H-H-H
[halɦabədʒi]	'grandfather'	H	H-H-H-H
[param]	'wind'	LH	L-H
[manura]	'wife'	LH	L-H-H
[ɦadʒuməni]	'aunt'	LH	L-H-H-H

(Note: In this article, the sound [ɦ] represents 'ieung' consonant)

The examples in (1) and (2) show that the tone pattern of a word is solely determined by the initial consonant. Whether the medial consonant is 'lax', voiceless aspirated, or voiced sonorant has no effect. Four-syllable words in (2) also show the same two tone patterns, although the tone may vary from the third syllables on (e.g., H-H-L-L or L-H-L-L). The variation suggests an optional rightward spreading of the H tone. Jun (1993: 42; 1996: 97; 1998: 193) suggests that in long words the H pattern is HHL in Jeonnam Korean but HHLH in Seoul Korean and the LH pattern is LHL in Jeonnam Korean but LHLH in Seoul Korean. However, M.-R. Kim (2000) did not find a consistent difference between the two dialects, i.e. Seoul Korean does not always end in H. In the discussion below I will focus on the correlation between the initial consonant and the H and LH patterns and ignore the variation in the realization of the two patterns.

3. Previous Analysis

I first review two theories of tonogenesis and then I review applications of such theories to Korean.

3.1. Theories of tonogenesis

Tonogenesis refers to the development of tone from the influence of neighboring consonants. Both the onset consonant and the coda consonant of a syllable can influence its tone (e.g. Haudricourt 1954 for Vietnamese and Baxter 1992 for Chinese). In this article I will focus on the former influence, which can be generalized as voiceless-high and voiced-low, namely, a voiceless onset consonant triggers a high tone and a voiced onset consonant triggers a low tone. Two

examples from Lhasa Tibetan and Shanghai Chinese are shown in (3), where H is a high tone and LH is a rising tone on a monosyllable (Hu 1980: 31, Duanmu 1992a).

(3) a. Historical Tibetan Lhasa Tibetan

k^ho	[k^ho]	H	'he'
go	[k^ho]	LH	'hear'

b. Shanghai Chinese

[se]	high rise	'umbrella'
[ze]	low rise	'wealth'

In (3a), a historically voiceless onset gave rise to a syllable with a high tone, and a historically voiced onset gave rise to a syllable with a low tone. In (3b), the high rise occurs with a voiceless onset and the low rise occurs with a voiced onset. There are some variations in the realizations of the two patterns (Duanmu 1992b). In any case, however, typical tonogenesis theories only deal with the correlation of voiceless-H and voiced-L.

There are two theories of tonogenesis, a listener-based theory (Hombert, Ohala, and Ewan 1979) and an articulatory feature-based theory (Halle and Stevens 1971). Hombert *et al.* provide extensive evidence that voiceless consonants raise the F0 of a vowel and voiced consonants lower the F0 of the vowel. They also offer some evidence that the F0 perturbation is perceptible. Finally, they cite some reports that F0 perturbation can help listeners distinguish between voiceless and voiced stops in certain contexts.

Halle and Stevens (1971) offer a different theory of tonogenesis. Their main proposal is that tone and voicing are different realizations of the same articulatory gestures: the stiffness of the vocal cords. Specifically, vocal cord tension is realized in obstruent consonants as the state of voicing and in vowels as tone, and the tonogenesis process is seen as the spreading of vocal cord features from the consonant to the vowel. If I use [+stiff] to represent a voiceless consonant or a high tone and [-stiff] to represent a voiced consonant or a low tone, tonogenesis can be analyzed as in (4), where [á] has a high tone, [à] has a low tone.

(4) Before feature spreading (no tone)

pa	ba
|	|
[+stiff]	[-stiff]

After feature spreading

pá	bà
|/	|/
[+stiff]	[-stiff]
(H tone)	(L tone)

Halle and Stevens also offered an analysis of Korean, to which I return below.

The two tonogenesis theories have certain similarities. For example, both assume that the articulation of voicing inherently affects F0. The theories also have a number of differences. For example, Halle and Stevens assume that voicing and tone involve the same articulatory gesture, whereas Hombert *et al*. do not. A consequence is that the Hall-Stevens analysis does not have to claim that the F0 perturbation is audible before feature spreading, because the feature for tone is already there in the consonants. Another difference is that Halle and Stevens assume that voicing and tone each involves just one articulatory gesture, the stiffness of the vocal cords, whereas Hombert *et al*. do not. In other words, the listener-based theory leaves it open for the possibility that voicing or tone each involves several possible articulatory mechanisms.

The differences between the two tonogenesis theories do not affect the present proposal. What is important is that as long as the consonant-tone correlation is voiceless-H and voiced-L, reasonable analyses are available. But when the correlation goes beyond voiceless-H and voiced-L, the analyses become problematic.

3.2. Analysis of Korean

I review three approaches (see below), focusing on how each analysis treats the consonant-tone relationship. Since most studies, unlike Jun (1990, 1993), did not directly discuss the interaction issue, I attempt to provide their analyses based on their treatment of consonantal features.

3.2.1 C.-W. Kim's analysis

C.-W. Kim (1965) assumes that Korean has three series of voiceless consonants. The minimal pairs, as given by C.-W. Kim (1965: 342), are shown in (5).

(5)

Initial	Medial
[p*ul] 'horn'	[i+p*ul] 'this horn'
[pul] 'fire'	[i+bul] 'this fire'
[p^hul] 'grass'	[i+p^hul] 'this grass'

Note that, unlike other series, the only lax series has a voiced allophone in medial position. In order to distinguish the three series of stops, as well as a voiced series, which are allophones of the lax series in medial position, C.-W. Kim proposes a new feature, 'tensity,' which is characterized as tension of articulation. He argues that the tensity feature is primary to distinguish Korean stops, and that tensity is independent of voicing and aspiration (1965: 357). According to C.-W. Kim, Korean stops are classified in terms of [tense] in (6).

Tone pattern

(6) [+tense] [p*, t*, tʃ*, k*], [p^h, t^h, $tʃ^h$, k^h] H
[-tense] [p, t, tʃ, k] (medially b, d, dʒ, g)) LH

According to (6), the consonant-tone interaction can be explained by the presence or absence of [tense]. In other words, if the word begins with [+tense] (or [+fortis] according to Gim 1997), the word has a H tone pattern; otherwise, the word has a LH tone pattern. The analysis proposed that, just as there is the well-known relation between voicing and tone, there is another relation, which holds between the feature [tense] and tone. The idea is originally proposed by C.-W. Kim and is reiterated in Jun (1996) and Gim (1997: 15).

There are some problems with the [tense]-tone analysis. First, since tensity is related multiple articulatory and acoustic properties, it is not obvious which characteristic contributes to raising or lowering the pitch of the vowel following a stop. Second, while there are languages that have undergone tonal differentiation based on voicing, such as Vietnamese (Haudricourt 1954), Chinese (Baxter 1992), and Tibetan (Hu 1980), Korean is the only reported language that has undergone tonal differentiation based on the feature [tense]. Similarly, although it is known that voicing perturbs F0 in many languages, there is little evidence that voiceless 'lax' consonants lowers F0 except in Korean. But in Korean voiceless lax stops co-occur with a low tone, so there is still no explanation why the correlation should be such.

3.2.2. Halle and Stevens' analysis

Following C.-W. Kim (1965), Halle and Stevens also assume that Korean has three voiceless consonants (see above). However, they propose two independently controlled parameters of the model: the stiffness of the vocal cords, and the static glottal opening. Based on these glottal parameters, they propose four laryngeal features, [spread glottis], [constricted glottis], [stiff vocal cords], and [slack vocal cords]. The combinations [+spread, +constricted] and [+stiff, +slack] are logically impossible. The four features proposed thus yield nine distinct phonetic categories of segments (Halle and Stevens, 1971: 203). Under their feature system, the four types of Korean obstruents phones are specified as in (7).

(7)

	p^h, t^h, k^h	p*, t*, k*	p, t, k	b, d, g
[spread]	+	-	+	-
[constricted]	-	+	-	-
[stiff]	+	+	-	-
[slack]	-	-	-	+

Since Halle and Stevens identify voiceless with H (both being [+stiff]) and voice with low (both [+slack]), it is possible to account for a relation between High tone and aspirated/tense consonants using a [+stiff] feature. In other words, according to this model, H tone can be simply realized as the spreading of the [+stiff] feature from the consonant to the vowel. However, since a lax consonant is defined as [-stiff, -slack], it gets a Mid tone, instead of a Low tone. This is shown in (8).

(8) Before feature spreading

pa	p*a
|	|
[-slack, -stiff]	[-slack, +stiff]

After feature spreading

pa	p*á
| /	| /
[-slack, -stiff]	[-slack, +stiff]
(M tone)	(H tone)

The consonant-tone interaction is seen as the spreading of vocal cord features from the consonant to the vowel, shown in (8), where [á] has a high tone (H) and the mid tone (M) is unmarked. The analysis of [p^ha] is similar to that of [p*a], so it is not shown. The voiced onset is not shown either, because in Korean it only occurs in medial position, whereas the consonant-tone correlation is only found in initial position. It can be seen that what the Halle-Stevens theory predicts is that the Korean tone patterns are H and M (or MH), instead of H and L (or LH) as Jun (1993) and M.-R. Kim (2000) assume. Korean also has voiced consonants in initial position, which are all sonorants. The sonorant onsets trigger the same tone as lax stops, so they must be analyzed as having the voicing features [-slack, -stiff], too, and trigger the M tone. It will be noted that in the aerodynamic model proposed by Halle and Stevens, [-slack, -stiff] is phonetically voiceless in stops and phonetically voiced in sonorants (Halle and Stevens 1971: 208); however, the issue need not concern us here.

There are three shortcomings in the Halle-Stevens analysis. First, a voiceless lax consonant's giving rise to Low tone in Korean, instead of Mid tone, is problematic in their system. Second, a system with H and M tones, instead of H and L, is rather rare; the same criticism applies to Gim (1969), who assumes that the Korean tone patterns are MHM and HHM. Third, to my knowledge, there is no language in which three tone levels (H, M, and L) developed after three types of unaspirated stops, such as [p* p b]. Finally, the Halle-Stevens system predicts more distinctions (nine possible feature combinations) than are actually known to occur in the world's languages.

3.2.3. Jun's analysis

There are four different analyses of Jun: Jun (1990), Jun (1993), Jun (1996), and Jun (1998). I review them in turn below.

Jun (1990) assumes that Jeonnam (Chonnam) Korean has the tone patterns HHL and LHL (which she calls 'accentual patterns') and argues that one of them can be considered the basic (underlying) form. She decided to consider LHL to be the basic form and use a rule to change it to HHL after tense and aspirated consonants ([+constricted] for tense and [+spread] for aspirated), because those consonants (both being voiceless) are known to raise F0. In Jun's (1990) analysis, it is unclear why LHL is the underlying pattern, nor how HHL is triggered by the feature [spread] or [constricted]. In addition, there is a question of why, unlike other voiceless consonants, voiceless lax consonants trigger L, instead of H.

Jun (1993: 52) notes that there is a problem in extending standard tonogenesis theories to the consonant-tone correlation in Korean. As she puts it:

> It is well known that … the vowel onset after voiceless consonants has a higher fundamental frequency compared to that right after voiced consonants. However, since Korean stops are all voiceless, the fact that only the voiceless lax stop initial Accentual Phrase starts with a low tone cannot be explained away as a consequence of the influence of a preceding consonant.

Since there is no satisfactory phonetic or phonological explanation for the consonant-tone correlation, Jun (1993) concludes that Korean tones are either underlyingly specified or assigned by rules that are either just partially related to consonant properties or not at all.

Jun (1993: 62-64) offers a somewhat different analysis of Chonnam. Consider her analysis of disyllabic words, such as those in (9).

(9)

[p^{h}araŋ]	H-HL	'blue'
[t*algi]	H-HL	'strawberry'
[param]	L-HL	'wind'
[miguk]	L-HL	'America'

In such words an underlying H is linked to the second syllable (her original proposal is to link H to the second mora, which in (9) is the second syllable). Then, if the initial consonant is aspirated or tense, H is spread to the initial syllable; otherwise L is added to the initial syllable. Finally, a final L is added by another rule. This is illustrated in (10).

(10) Underlying	H-Spread	Initial-L	Final-L
[p^{h}araŋ]	[p^{h}araŋ]	N/A	[p^{h}araŋ]
|	\ |		\ | \
H	H		HL
[t*algi]	[t*algi]	N/A	[t*algi]
|	\ |		\ | \
H	H		HL
[param]	N/A	[param]	[param]
|		| |	| |\
H		L H	L HL
[miguk]	N/A	[miguk]	[miguk]
|		| |	| |\
H		L H	L HL

Although the rules H-Spread and Initial-L are conditioned by initial consonants, there is no explanation for the condition, as pointed out by Jun (1993: 52). In particular, there is no explanation why voiceless lax consonants should group with voiced consonants, instead of other voiceless consonants. Thus, the two rules are essentially arbitrary.

Jun's (1996) analysis solved the problem of the relation between H tone and aspirated and tense consonants by replacing the underlying laryngeal features [spread glottis]/[constricted glottis] with [stiff vocal cords], following Halle and Stevens (1971). Consequently, aspirated and tense consonants—both of which are [+stiff]—give rise to a H tone. As discussed earlier, this H tone was explained by Jun (1993, 1996) as *phonologized* (i.e., underlying) at the level of Korean intonational phonology. Jun viewed the phonologized H tone of the language as similar to the phrase-initial strengthening phenomena found in the production data of other languages.

Jun's (1998) analysis went beyond her earlier (1993, 1996) analyses in that she not only viewed the phrase-initial H tone as a phonologized intonational property of a phrase in Korean, but also viewed L as phonologized. That is, Jun (1998) proposed that, both tonal patterns are underlying, with the two patterns being determined by the underlyingly laryngeal feature ([±stiff]) of the phrase-initial consonant.

Jun's more recent analyses (1996, 1998), while accounting for the correlation between H tone and aspirated and tense consonants (as [+stiff]), leave unexplained the L tone for other consonants. Jun (1998) suggested that the correlation between consonant types and tone was historically phonetically motivated, but is now phonologized, with the relation between consonant types and tone being no longer explainable in phonetic terms. These analyses also leave some questions. First of all, if tones are phonologized, why are consonant-tone interactions fully predictable in domain-initial position? Secondly, following Halle

and Stevens' system, if lax consonants are specified as [-stiff], why is there an initial L tone, instead of a Mid tone? Most other questions raised above also remained unaccounted for.

4. Present Analysis

The present analysis mainly differs from previous analyses in that it assumes that the underlying form of the lax consonant is the voiced variant (see below), instead of the voiceless one. It interprets the consonant-tone interactions in Korean as an ongoing process of tonogenesis due to voiceless-H and voiced-L. It agrees with Jun's idea that (i) every tonal pattern is predictable from an initial segment of an accentual phrase and (ii) the interaction needs a phonological explanation since it is beyond low-level phonetic effect. However, it differs from Jun's analysis in two aspects. First, tones are not yet phonologized but are still fully predictable from underlying voicing. Second, the interaction does not occur in medial position because of the presence of voicing. In subsequent sections, a more detailed discussion is presented.

4.1. A lax-voicing hypothesis

According to C.-W. Kim (1965), Korean has three series of stops in syllable onset position, as shown in (11). In syllable coda position there is only one series of stops (unreleased and glottalized), which I ignore.

(11)

	Initial onset	Medial onset	Tonal correlation
Aspirated	p^h, t^h, $tʃ^h$, k^h	(same)	H
Tense	p*, t*, tʃ*, k*	(same)	H
Lax	p, t, tʃ, k	b, d, dʒ, g	LH

Aspirated and tense stops do not vary. Lax stops are voiceless initially and voiced medially when they occur between two vowels (e.g. C.-W. Kim 1965: 346, Jun 1990: 126; see Silva 1992 and Jun 1994, 1995 for different views on medial voicing). Phonemically, therefore, either set of allophones can be chosen as the underlying forms for lax stops. If I choose the voiceless set as the underlying forms, a voicing rule must be proposed for the medial set. If I choose the voiced set as the underlying forms, a devoicing rule must be proposed for the initial set.

Many studies chose the voiceless set to be the underlying forms for lax stops, such as C.-W. Kim (1965), Halle and Stevens (1971), Ahn (1985), Huh (1985), K.-H. Kim (1987), and Jun (1993). On the other hand, some studies use the voiced set to represent the lax stops, such as Jones (1950), Hashimoto and Yu (1972), B.-G. Lee (1976), Moon (1974), Oh (1981), and Choi (1995). I will discuss below that, if lax stops are underlyingly voiced, the consonant-tone correlation has a straightforward explanation.

The choice of the underlying representation for lax stops has consequences for the representation of other stops. In particular, if the

lax stops are distinguished by [+voice] (i.e., [-stiff]=slack vocal cords in this study), there is no need for the feature [tense]. I return to this issue in section 5.

4.2. Voiceless-H vs. voiced-L

If lax stops are underlyingly voiced, the consonant-tone correlation in Korean is one of voiceless-high and voiced-low, which is a standard case of tonogenesis. As discussed in section 3.1, there are several approaches to tonogenesis. Since differences among them are not essential, I present my analysis in the Halle and Stevens approach (see section 3.2.2). However, some modification will be made in order to avoid the problems in the Halle-Stevens analysis.

The present analysis adopts Halle and Stevens' (1971) proposal that the stiffness of the vocal cords is realized as voicing in obstruent and tone in vowels; both voicelessness and H are related to stiff vocal cords and that voicing and L are related to slack vocal cords. Unlike Halle and Stevens, who assumes the two features [stiff] and [slack] (for a similar proposal, Avery and Idsardi 2000), I use just one feature, [±stiff] (where [-stiff] makes an obstruent to be voiced and a vowel to be L, and [+stiff], which makes an obstruent to be voiceless and a vowel to be H). This analysis solves the Halle and Stevens' problem which allows more consonantal contrasts than have been reported to occur in the actual world's languages (for similar proposals, see Keating 1990, Duanmu 1992a, 1996). In addition, unlike their analysis, sonorants and lax consonants in Korean are analyzed as having slack vocal cords, instead of being [-stiff, -slack]. This is because, as pointed out Maddieson (1984), voiced sonorants and voiced obstruents result in similar F0 perturbation. Thus, sonorants that have no voicing distinction get [voice] by default which causes slack vocal cords. (12) represents stops with the feature [stiff]. Sonorants and other consonants are discussed below. For the time being I continue to indicate the tense stop with [*]. In section 5.2 I will discuss whether [*] can be omitted.

(12) [stiff]	-	+	+
Obstruents	b ('lax')	p* ('tense')	p^h (aspirated)
Vowels	L	H	H

The creation of tone on the vowel can be analyzed in several ways. Consider stops first. I will assume the following analysis. First, the vowel has no tone originally. Next, the [stiff] feature spreads from the consonant to the vowel, creating L after a voiced stop and H after a voiceless stop. Finally, devoicing applies. This is shown in (13).

(13) Underlying	Spreading	Devoicing
b a	b à	p à
|	|/	| |
[-stiff]	[-stiff]	[+stiff][-stiff]
p* a	p* á	(no change)
|	|/	
[+stiff]	[+stiff]	
p^ha	p^há	(no change)
|	|/	
[+stiff]	[+stiff]	

To get LH for the syllable with a voiced stop, I may assume rule (14a)—Tonal Polarity. If the patterns are HL and LHL, I may assume another step, stated in (14b)—Default L. These further steps are illustrated in (15).

(14) a. Tonal Polarity: An initial L must be followed by H
b. Default L : Any toneless moraic segment would get L.

(15) Input	Polarity	Default L	Output
H	—	HL	HL
L	LH	LHL	LHL

To obtain the H(L) and LH(L) of Korean multi-syllabic words, one more rule can be posited: optional H spreading. H tone can spread from left to right across moraic segments and any moraic segments that remain toneless will get a L tone by default.

There may also be other ways of getting LH for the syllable with a voiced stop. For instance, one can assume that every word must have an H tone. The analysis can also be cast in Optimality Theory, which is not discussed here (see M.-R. Kim 2000, Chapter 6).

There is another possibility in the treatment of the devoicing process. Instead of assuming that the devoiced 'lax' stop becomes [+stiff], one may assume that it is simply de-linked from its original [-stiff] and now has no value for [stiff]. This proposal essentially allows a three-way contrast under a binary feature system, which is an issue of some controversy in feature theory. I will not pursue it here, because I see no need to abandon the traditional binary feature system (see section 5.2).

I have discussed stops. Korean also has fricatives and sonorants. Since all fricatives are voiceless and trigger the H pattern, their analysis is similar to that of voiceless stops. Korean sonorants are voiced and trigger the LH pattern. Their analysis is similar to that of a voiced stop (traditionally called 'lax' stop), i.e. the L tone is the result of spreading [-stiff] from the consonant to the vowel. The difference between a voiced stop and a sonorant is that sonorants do not devoice. An example is shown in (16).

(16) Underlying	Spreading	Devoicing
ma	mà	(no change)
|	|/	
[-stiff]	[-stiff]	

Korean also has a consonant that is traditionally called 'ieung'. It has no oral constriction and its transcription varies in the literature (W.-J. Kim 1967, K.-M. Lee 1972, Park 1983, S.-S. Kim 1995, Gim 1997). Since syllables with 'ieung' trigger the LH pattern, I consider it to be a voiced glottal sound [ɦ].

The present analysis shows that the consonant-tone interaction depends on the phonological voicing of consonants, as summarized in (17). Stops can be voiced or voiceless and can trigger either the H or the LH pattern. Since all fricatives are voiceless and trigger the H pattern, their analysis is similar to that of voiceless stops. Sonorant and 'ieung' consonants are voiced and trigger the LH pattern.

(17) Phonological voicing	Tonal patterns
a. Voiceless onsets (aspirated, tense, s^h, s*, h):	H(L)
b. Voiced onsets (ɦ, sonorant, lax):	LH(L)

The present analysis raises two questions. First, why does the consonant-tone interaction occur in initial position only? Second, what is the difference between the devoiced lax stop and the tense stop? For the first question, I follow Jun (1996) and assume that the beginning of an accentual phrase has a special effect on prosody, in this case devoicing; I will return to this issue below. The second question is addressed below.

5. Further issues

In this section I discuss two further issues: (a) whether the accentual phrase plays a role in other tonogenesis languages and (b) the feature [tense] (for more issues, see M.-R. Kim 2000, M.-R. Kim and Duanmu ms).

5.1 Does the accentual phrase play a role in other tonogenesis languages?

In Korean the consonant-tone interaction occurs only at the beginning of an accentual phrase. If what happens in Korean is tonogenesis, one may wonder whether the accentual phrase also plays a role in other languages that have undergone tonogenesis. I examine two cases: Shanghai Chinese and Lhasa Tibetan.

Consider Shanghai Chinese (Duanmu 1995) first. If I ignore tonal registers (basically, vowel murmur conditioned by underlying consonant voicing, which can also affect pitch height), Shanghai has two tone patterns, LH and HL. Now consider the examples in (18).

(18) Tone in Shanghai Chinese

[sɑ̃]	HL	‘business’
[du]	LH	‘big’
[ɲĩ]	LH	‘person’
[sɑ̃-ɲĩ]	H-L	‘businessman’
[du-ɲĩ]	L-H	‘big-person (adult)’

As in (18), each monosyllabic word in Shanghai has a tone pattern. But in a disyllabic Shanghai compound only the initial syllable has a tone pattern, which is spread over both syllables. For example, the tone pattern of ‘businessman’ is the same as ‘business’ (i.e. HL), and the tone pattern of ‘big-man (adult)’ is the same as ‘big’ (i.e. LH). Thus, Shanghai is similar to Korean in that the tone pattern of a polysyllabic domain is determined by the initial syllable only.

Next consider Lhasa Tibetan, which has undergone tonogenesis quite recently; in fact, some Tibetan dialects are still not tonal (Hu 1980, Qu and Tan 1983, Duanmu 1992b). Like Korean, Lhasa Tibetan has two tone patterns, H and LH, where H occurs with a syllable whose onset is historically voiceless and LH occurs with a syllable whose onset is historically voiced. Now consider the examples in (19).

(19) Tone in Lhasa Tibetan

[tɕ^{h}a]	LH	‘tea’
[ma]	LH	‘butter’
[tɕ^{h}a-ma]	L-H	‘tea-butter (tea and butter)’
[ta]	H	‘horse’
[tʂe]	LH	‘mule’
[ta-tʂe]	H-H	‘horse-mule (horse and mule)’

In isolation every monosyllabic word has a tone pattern, either H or LH (Duanmu 1992b). As in Korean and Shanghai, the tone pattern of a disyllabic compound is determined by the initial syllable. For example, the tone pattern of the compound ‘tea-butter’ is the same as that of ‘tea’ (LH), and the tone pattern of the compound ‘horse-mule’ is the same as that of ‘horse’ (H).

The above discussion shows that Korean is not unusual in that only the initial syllable of a domain affects tone.

5.2 The feature [tense]

C.-W. Kim (1965) argues that the two traditional features ([voice] and [aspirated]) cannot account for Korean, because Korean has three series of voiceless stops. As a solution, he proposes a new feature [tense] (see section 3.2.1). However, the feature [voice] is still needed to distinguish the two allophones of a ‘lax’ stop. Now, in C.-W. Kim’s proposal ‘both tensity and voicing are autonomous cross-cutting features for stops’ (p.357). Therefore, along with the feature [aspirated], eight possible stops can be predicted for each place, shown in (20).

(20)	[voice]	+	+	+	+	-	-	-	-
	[tense]	+	+	-	-	+	+	-	-
	[aspirated]	+	-	+	-	+	-	+	-
	Example	$b^{\text{ɦ}}$*	b*	$b^{\text{ɦ}}$	b	p^{h*}	p*	p^{h}	p

However, there is no reported language that has so many stops. In addition, I am not aware of compelling evidence in any language for a contrast between [$b^{\text{ɦ}}$*] and [$b^{\text{ɦ}}$], or [p^{h*}] and [p^{h}], or [b*] and [b].[2] In fact, even in Korean there is no minimal contrast between voiceless tense and voiceless lax stops. C.-W. Kim (1965: 342) offers the words in (21) as such minimal pairs.

(21)	[p*ul] 'horn'	[t*al] 'daughter'
	[pul] 'fire'	[tal] 'moon'

However, subsequent studies have discovered that such pairs also differ in tone (e.g. Jun 1993, M.-R. Kim 2000). A full representation, therefore, should include tone, as in (22).

(22)	[p*ul] 'horn'	[pul] 'fire'
	|	/\
	H	LH

Clearly, this is not a minimal pair. What I know is that Korean speakers can tell a difference between the two words, but it does not tell us whether the difference lies in the onset consonants, or in tone, or in both. Literate Korean speakers may feel that the difference lies in onset consonants, but that may be because the orthography uses different symbols for onset consonants but no symbol for tone. On the other hand, perception studies show that the difference primarily lies in tone rather than in onset consonants (M.-R. Kim 2000, Chapter 5). In any case, there is no compelling evidence that Korean has a phonemic contrast between voiceless lax and tense stops.

In the present analysis, the 'lax' stops are voiced underlyingly, so there is no need to assume the feature [tense] (or [fortis]). The analysis is shown in (23), where for familiarity I use [voice] instead of [stiff].

(23)	Features	Example	Old label
	[+aspirated, -voice]	[t^{h}]	aspirated
	[-aspirated, -voice]	[t]	tense
	[-aspirated, +voice]	[d]	lax

Interestingly, while there are no minimal pairs for voiceless lax and voiceless tense stops, there are some minimal pairs for voiced (so-

[2] Tyap and Jiu reportedly has a contrast between voiced lenis and voiced fortis consonants, such as [b*] and [b], but as McKinney (1990) points out, the difference mainly lies in aspiration. Since Tyap and Jju consonants do not otherwise contrast in aspiration, there is a possibility that the reported difference between [b*] and [b] is in fact between [$b^{\text{ɦ}}$] and [b] instead.

called ‘lax’) and voiceless unaspirated (so-called ‘tense’) obstruents in medial position. Some examples are shown in (24). Following the present analysis, a ‘lax’ consonant is written as a voiced one underlyingly and a ‘tense’ consonant is written as a plain one (without [*]). Syllable boundaries are indicated by a dot.

(24) Underlying	Surface	Tone	Gloss
/goŋ.dʒa/	[koŋ.dʒa]	L-H	‘Confucius’
/goŋ.tʃa/	[koŋ.tʃa]	L-H	‘gratis’
/goŋ.tʃ^{h}a/	[koŋ.tʃ^{h}a]	L-H	‘allowance’

The three affricates occur in the same environment, including tone. Thus, they provide genuine minimal contrasts among voiced /dʒ/, voiceless unaspirated /tʃ/, and voiceless aspirated /tʃ^{h}/ obstruents .

The question now is whether I need the feature [tense] to distinguish obstruents in initial position, which are all voiceless. The solution depends on whether there is a three-way contrast or two-way contrast in initial position. Compare the two views in (25) and (26).

(25) Three-way contrast in initial stops
[t^{h}al] H ‘mask’
[t*al] H ‘daughter’
[tal] LH ‘moon’

(26) Two-way contrast in initial stops
[t^{h}al] H ‘mask’
[tal] H ‘daughter’
[tal] LH ‘moon’

Since the first word is distinguished by aspiration, I will focus on the latter two words. According to (25), the second and third words differ in both [tense] and tone. According to (26), they differ in tone only. If (25) is correct, I expect there to be some phonetic differences between [t*] and [t], which C.-W. Kim (1965) has shown. On the other hand, there are some problems with (25). First, there is no minimal pair to justify the contrast between [t*] and [t] (or between any other tense-lax pair in initial position). Second, perception experiments show that, to distinguish [t*al] and [tal], the difference in tone is more important than the difference between [t*] and [t] (M.-R. Kim 2000, Chapter 5). Third, the analysis in (25) requires an additional feature [tense], which, when combined with [voice] and [aspirated], predicts too many contrasts that are not found in natural languages.

If I assume the analysis in (26), I do not have the problems in (25). On the other hand, I must explain why initial ‘tense’ and ‘lax’ consonants are different phonetically, even though they are represented the same way, i.e. [-aspirated, -voice]. A possible answer is that the differences are due to co-articulatory effects, i.e. the influence of the following tone. For example, C.-W. Kim (1965) points out that the initial ‘lax’ stop is generally accompanied by less energy than other stops (e.g. less burst energy, weaker waveform and

slower vocal cord vibration after burst). This agrees with the fact that a high tone usually has more energy than a low tone. It will be noted that although some co-articulatory effects can be represented phonologically, such as voicing assimilation in the English suffix /s/ (e.g. [z] in 'bags' and [s] in 'backs'), others should not, such as formant transitions of [a] after [p t k]. Thus, unless there is other evidence (such as a minimal pair of contrast), the phonetic differences between initial 'tense' and 'lax' consonants alone do not warrant a new phonological feature.[3]

There is another way to account for a three-way initial contrast. Instead of assuming the feature [tense], one can assume that the 'tense' stop is [-voice] and the 'lax' stop lacks the value for [voice]. This approach assumes that it is possible to get a three-way contrast for each binary feature (e.g. [+voice], [-voice], and no value for [voice]). However, in the present analysis, there is no compelling reason for such an approach.

It should be noted that if there is indeed a three-way contrast in initial stops, the present analysis can also assume the feature [tense], and it is still better than previous analyses in accounting for the consonant-tone correlation in Korean. On the other hand, the present analysis is perfectly compatible with (26), whereas others are not, such as C.-K. Kim (1965) and Jun (1993, 1996).

6. Conclusions

In this study I have offered an alternative analysis of the so-called lax consonants with special reference to the consonant-tone correlation in Korean. The main difference between my approach and previous ones lies in the analysis of the so-called 'lax' stops, which are voiceless in initial position and voiced in medial positions. Unlike previous analyses, which assume the voiceless allophones to be the underlying forms, I propose that the voiced allophones be the underlying forms. On this view, the consonant-tone correlation in Korean is no longer problematic, as it has been in previous studies. Instead, it is one of voiceless-high and voiced-low, which is commonly found in tonogenesis.

The present analysis also offers the possibility of a further simplification in Korean phonology, namely, the feature [tense] may not be needed at all. In particular, the so-called three-way contrast in initial stops may not lie entirely in the stops themselves. Rather, there is only a two-way contrast, an aspirated voiceless stop and an unaspirated voiceless stop. The purported contrast between the so-called 'tense' and 'lax' stops (both voiceless and unaspirated) lies in the tone of the vowel, as illustrated in (26).

[3] If tone can affect consonants in Korean, I expect the same to occur in other tone languages. In Standard Chinese (Mandarin), voiceless unaspirated stops can occur before H or L tone, such as [pan] H 'class' and [pan] L 'board'. To Korean speakers, the former [p] sounds like a 'tense' stop and the latter [p] sounds like a 'lax' stop. Phonetic studies remain to be done as to whether the two Chinese [p]s have the same difference as initial 'tense' and 'lax' stops in Korean.

Two questions can be raised. First, why is the consonant-tone correlation limited to initial position only? This question is relevant not only for the present analysis but also for previous analyses. As a partial answer, I offered evidence that other tone languages can exhibit domain initial effects, too, such as Shanghai Chinese and Lhasa Tibetan. Therefore, Korean is not unique in this respect. The second question is, if I do not have the feature [tense], initial 'lax' and 'tense' stops are identical, both being [-aspirated, -voice], why then are there phonetic differences between them, as documented by C.-W. Kim (1965)? The answer I suggested is co-articulation, namely, the 'tense' initial stop is followed by a H tone and the 'lax' initial stop is followed by a L tone; the phonetic differences between the two stops are likely due to the influence of the following tones. Since not all co-articulatory effects warrant phonological representation (for example, formant transitions of [a] after [b d g] are not represented by phonological features), phonetic differences alone between the two initial stops do not warrant introducing the feature [tense]. Overall, I believe that the present proposal is at least as strong as any other proposal and is worth serious consideration.

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