

Non-glottalization in Korean Fortis Consonants

Wei-rong Chen^{1,*}

¹ Graduate Institute of Linguistics, National Tsing Hua University, Taiwan

* Corresponding author.

Supported in part by the ‘Monsoon Asia project’ granted from the Research Center for Humanities and Social Sciences, National Tsing Hua University, Taiwan. My special thanks go to Korean Mission in Taipei as well, from which the project grant of ‘Research on Korean studies’ was awarded to this paper.

Received 13 December 2011; accepted 22 February 2012.

Abstract

It is claimed that the three types of obstruent consonants in Korean (fortis/lenis/aspirated) are currently undergoing a diachronic change in articulation in that the differences in the voice onset time (VOT, in association with the degree of aspiration) is becoming not completely contrastive while the contrasts in pitch height (fundamental frequency) surface as a more reliable perceptual cue. Controversy still exists whether this change brings in concomitant modifications in other articulatory dimensions, especially the presence of glottalization, commonly used to manifest the notion of articulatory fortisness in the literature. The aim of this study is to examine whether the presence/absence of glottalization holds in the contrast of fortis/lenis consonants in the contemporary Korean language, by directly observing the glottal states via a trans-nasal fiberscope (laryngoscope). Our results elicited from Seoul subjects in younger generation of 30s show that the glottal constriction states of Korean fortis consonants exhibit no observable glottalization, in terms of the Six Valves of Throat Framework for sub-glottal reinforcements.

Keywords: Laryngoscope; Korean language; Glottalization; Fortis consonants

Résumé

On a proposé que les trois types des consonnes obstruante du coréen (fortis/lenis/aspirées) sont en cours de change-

ment diachronique de leur articulation. Les différences de délai de voisement (ou VOT), marquant différents degrés d’aspiration ne sont plus complètement contrastives, tandis que les différences de hauteur mélodique (F0) sont devenues des indices plus fiables en perception. Les opinions divergent sur la question de savoir si ce changement entraîne des modifications concomitantes sur d’autres dimensions articulatoires, notamment la glottalisation, souvent considérée dans la littérature comme corrélat de l’articulation “fortis”. Notre étude vise à examiner si la présence/absence de glottalisation est maintenue dans le contraste fortis/lenis des occlusives du coréen contemporain, à l’aide de l’observation directe de la glotte par fibroscopie nasale (laryngoscopie). Nos résultats obtenus avec des locuteurs de Séoul âgés d’une trentaine d’années ne montrent pour la constriction glottale des consonnes fortis aucun des signes de glottalisation proposés dans le cadre des “Six Valves of Throat for sub-glottal reinforcements” [six valves de gorge pour le renforcement sub-glottique] de Edmondson & Esling.

Mots clés: Laryngoscopie; Langue coréenne; Glottalisation; Consonnes fortis

Wei-rong Chen (2012). Non-glottalization in Korean Fortis Consonants. *Canadian Social Science*, 8(1), 44-49. Available from: URL: <http://www.cscanada.net/index.php/css/article/view/j.css.1923669720120801.336>
DOI: <http://dx.doi.org/10.3968/j.css.1923669720120801.336>

Korean language possesses its unique status in linguistics in that there is a rare contrast in phonation that divides Korean obstruent consonants into three types: fortis, aspirated, and lenis type. This contrast is unusual because, for most human languages where three-way phonation contrast exists, the contrast can be explicitly depicted by ‘voicing’ and ‘aspiration’ parameters (Ladefoged & Maddieson, 1996); for Korean, on the other hand, the contrast is otherwise demarcated by ‘aspiration’ and a rather abstract parameter—‘fortis/lenis’ distinction. This fortis/

lenis distinction, which is rather unclear in definition and uneasy to be comprehended, not only has posed issues to linguists but also has confused non-native learners in learning Korean (Second language learners / L2 learners). Since this famous three-way phonation contrast in Korean came to researchers' knowledge, many studies have been conducted in attempts to explore the phonetic parameters encoded in it. While this enigma has been, in part, deciphered by consecutive research works, only recently, Silva (2006a, 2006b) reported that this three-way phonation contrast in Korean has been changing in its realization of Voice Onset Time (henceforth, VOT), over the past few decades. This finding opened up more research questions. Given that VOT is an acoustic measure that reflects some articulatory processes (the relative timing between oral articulation and glottal constriction) and many of the human articulatory apparatuses operate in synergy, the so-claimed change in VOT could have brought about accompanying changes in other articulatory dimensions. Thus, the purpose of this study is to investigate into the subglottal articulations, which have been claimed to be patterned with VOT (H. Kim, Honda, & Maeda, 2005), for the three types of consonants in contemporary Korean, by means of laryngoscopic observations. The result of the current study is expected to contribute to the development of not only linguistic theories but also theories in the field of Teaching Korean as Second Languages.

1.2 Literature Review

Korean fortis consonants (also known as 'strong' or 'tense' type) have been characterized by researchers with the notion of being articulatorily reinforced or "glottalized" (Ogura, as cited in C.-W. Kim, 1970; Maddieson, 2005; Martin, 1951), while lenis consonants (also known as 'weak' or 'lax' type) with the opposite. Upon the earliest research works, in around 1950s to 1970s, there was a consensus acknowledgement that VOT is one of the key acoustic cues for distinguishing these three phonation types in Korean consonants: The fortis type has the shortest VOT, aspirated one the longest and lenis one intermediate (e.g., Abramson & Lisker, 1971; C.-W. Kim, 1965). Yet some studies (Han & Weitzman, 1970; C.-W. Kim, 1965) noted that the fortis and lenis types share a considerable amount of overlapping in VOT, implying that there must be additional phonetic cues collaborating with VOT in contrasting these three types. A systematic variation in Fundamental Frequency (F0) for the Korean three-way phonation contrast was then being identified in many subsequent works (e.g., Han & Weitzman, 1970; Umeda & Umeda, 1965, among others), in the sense that F0 value at the voice onset for syllables with initial fortis consonants is the highest, slightly lower in the cases of aspirated consonants, and the lowest in the cases of lenis consonants, as a supplementary contrasting cue, though there is no significant difference between the fortis type and the aspirated type.

In Kagaya's (1974) fiberoptic study, the sub-glottal images of vocal folds during the production of Korean three types of consonants were first documented, and a conclusion was drawn that Korean fortis consonants are characterized with "completely adducted state of the vocal folds before the articulatory explosion, stiffening of the vocal folds and their abrupt relaxation near the voice onset" (p. 161), a state that meets the criteria of 'glottalization' or 'glottal stop' in terms of traditional phonetic view, suggesting an association of glottal/vocal folds reinforcement with the abstract sense of fortisness for Korean fortis consonants. Another remark concluded in Kagaya's study lies on the observation that the glottal opening varies as a function of the three phonation types in that the fortis type has the smallest glottal width, the aspirated the largest, and the lenis type the intermediate, a finding which is also supported in C.-W. Kim's (1970) cineradiographic study and another fiberoptic study conducted by Jun, Beckman, and Lee (1998).

Aside from the sub-glottal configurations mentioned above, supra-glottal (i.e., oral tract) states have also been studied in exploring the Korean three-way phonation types. Some studies by means of linguopalatogram (Cho & Keating, 2001; C.-W. Kim, 1965; H. Kim, 2001) and acoustic measurements of consonant closure duration (Cho, Jun, & Ladefoged, 2002), pointed out that the fortis type exhibit the largest linguopalatal contact and the

1. BACKGROUND

1.1 Korean Obstruent Consonants

Obstruent consonants in Korean language can be categorized into three manners of articulation: plosive, affricate, and fricative, where plosives draw on three places of articulation (lip, alveolar, and velum) and affricates/fricatives only one (alveolar). In syllable-initial position, plosives and affricates can be subdivided into three phonation types (fortis /p' t' k' ts'/, aspirated /p^h t^h k^h ts^h/, lenis /p t k ts/), while fricatives have only two (fortis /s'/, lenis /s/), as shown in Table 1:

Table 1
Korean Obstruent Consonants

Consonant type	Place of articulation		
	Lip	Alveolar	Velum
Plosive			
Fortis	ㅍ /p'/	ㅌ /t'/	ㅋ /k'/
Aspirated	ㅍ ^h /p ^h /	ㅌ ^h /t ^h /	ㅋ ^h /k ^h /
Lenis	ㅍ /p/	ㅌ /t/	ㅋ /k/
Affricate			
Fortis		ㅈ /ts'/	
Aspirated		ㅈ ^h /ts ^h /	
Lenis		ㅈ /ts/	
Fricative			
Fortis		ㅅ /s'/	
Lenis		ㅅ /s/	

longest closure duration, whereas lenis type has the least in both measures and in between for the aspirated type.

As is suggested in H. Kim et al.'s (2005) MRI study, one can find in the abovementioned review that there is likely to be two independent mechanisms corresponding to the Korean three-way phonation types: one is the sub-glottal system which bids vocal folds to be adducted (closing) for fortis type, neutral (no active control) for lenis type and abducted (opening) for aspirated type, and in turn results in the VOT values associated with the glottal width in the same order as fortis < lenis < aspirated; the other mechanism concerns the supra-glottal system (oral articulation), whereby the degree of tongue-to-palate constriction ranges from the most extended (gesture overshoot) to the least (gesture undershoot) in the order: fortis > aspirated > lenis, and, evidenced from Kim et al.'s MRI study, the tongue movement causes an acoustic consequence of F0 varying from high to low in the same order.

Most recently, Silva (2006b) revealed an ongoing sound change taking place in the phonetic representations of the Korean three-way phonation types. Supported by his acoustic study of VOT variations with 34 Korean subjects across generations, Silva claimed that for younger Koreans (about 30~ 40s), the VOT values of lenis and aspirated plosives have been merging (let alone the VOT values of the fortis type intact), while other phonetic cues, like F0 or closure duration, are maintained. That can also be interpreted as, in terms of H. Kim et al.'s (2005) two-mechanism-view, a shift from sub-glottal system (vanishing of VOT contrasts) to supra-glottal mechanism (maintaining the contrasts in F0 and closure duration).

1.3 The Aim of the Current Paper

Thus, a question arises: While it is evidenced to be a change in VOT realizations of the Korean three-way phonation contrasts, does it presuppose a change in the glottal states as well, since VOT is an acoustic output form of sub-glottal configurations? The thesis of the present study centers on this issue. In particular, whether the previously assumed 'glottalization' for the Korean fortis consonants (Ogura, as cited in C.-W. Kim, 1970; Maddieson, 2005; Martin, 1951) still holds in the contemporary Korean was to be explored in this study.

The method employed in this paper is to directly observe the movements of the whole sub-glottal system via a trans-nasal fiberscope (laryngoscope), during the production of syllables with the three types of Korean consonants. Fiberscopic observations of glottis in examining the articulation of Korean consonants have been performed for times in the literature (e.g., Jun et al., 1998; Kagaya, 1974, among others). Among them, only Kagaya (1974) has made a clear description of a completely adducted state of vocal folds in producing fortis consonants. In the rest of the other laryngoscopic studies, whether 'glottalization' exists in the production of fortis consonants were

not reported. In observing the glottal images retrieved from the latest laryngoscopic study of Korean consonants (Jun et al., 1998), though good profiles of glottal states were provided, the readers may not be fully assertive in determining the existence of glottalization and/or reinforced glottal movement due to the insufficiency in the resolution of the images (as in Figure 1).

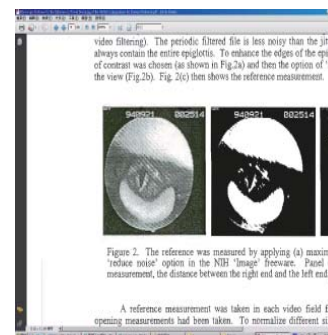


Figure 1
Example of Glottal Image Retrieved from Jun et al. (1998)

Furthermore, in the traditional view, the presence of glottalization was defined merely as a 'complete closure state of vocal folds' (Ladefoged & Maddieson, 1996), a definition proved to be insufficient to describe some cases of glottalization in recent literature (e.g., Edmondson & Esling, 2006).

Benefitting from the most up-to-date advancement in laryngoscopic technology, Edmondson and Esling (2006) have developed a more sophisticated method in evaluating glottal states, dubbed as *valves of the throat framework*. As suggested in this framework, six sub-glottal apparatuses, called *valves*, operate in synergy in responsible for the presence of glottalization, or, more precisely, 'degree of glottal reinforcement'. The six values are listed as the following: Valve 1: Vocal fold, Valve 2: Ventricular folds, Valve 3: Aryepiglottic folds, Valve 4: Epiglottal tubercle, Valve 5: Pharyngeal wall, and Valve 6: Glottal Depressor/Elevator. The first four valves (Valve 1 ~ 4, as shown in Figure 2) are ordered roughly in the degree of glottal reinforcement from the mildest to the most intense (Valve 5 and Valve 6 function in other aspects, which are beyond the scope of the present study). The framework has been developed upon studies of various languages spanning over 17 language families, under which a proclivity emerges that, at least for the first four valves, the engagement of higher level valve supposes the engagement of valves of lower levels; i.e., If Valve 3 should engage, there would be a least some engagement of Valve 1 and Valve 2. For cases with moderate glottalization, one would see engagement of Valve 1 and Valve 2, and for cases with stronger glottalization, engagement of higher level valves (Valve 3 or Valve 4) would be involved (Edmondson, Chang, Hsieh, & Huang, 2011).

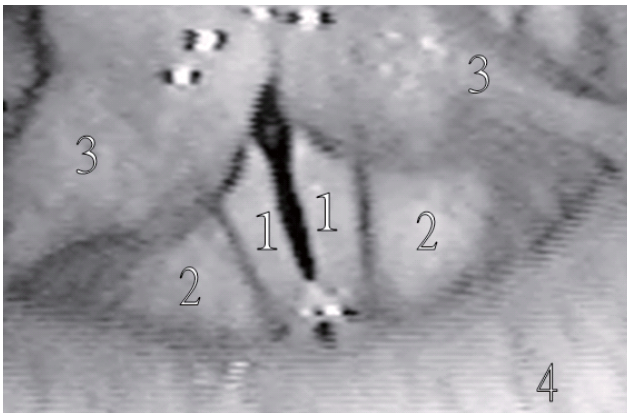


Figure 2
Valves of Subglottal System (valve 5 and valve 6 are not present). Numbers on the figure indicate the valve numbers defined in Edmondson and Esling's (2006) work

Thus, in order to fully explore the sub-glottal operations for the Korean obstruent consonants, in the present study we evaluated the degree of glottalization by the norms described in valves of the throat framework, rather than merely looking at the opening of glottal folds.

METHOD

Two native speakers of Korean (LLM, female, and SJH, male) served as the subjects; the subjects were 25-35 years of age. Both of them have good command of Seoul dialect of Korean, and have no reported speaking or hearing impairments. Each subject was asked to produce utterances of a series of randomized test words displayed on paper sheets, in the form of properly-sized standard Korean orthography (Hangul). The glottal images and speech sounds of the utterances were synchronically recorded by devices of Olympus ENF-V2 Rhino-laryngo-Digital Videoscope with OTV-SI(A) (diameter: 3.2mm; imaging rate: 30 frames/s) and H4 digital audio recorder with Beyerdynamic TG-X 80 microphone, respectively. The two devices were mounted on an Apple Macbook, for capture with QuickTime Pro. The test-word stimuli consist of CV combinations, where C stands for each of the consonants in Table 1 and V for /i/ vowel. The experiment has been repeated for two times for each subject.

The experiments took place at the Chu-tung branch of National Taiwan University Hospital in Hsinchu County, Taiwan. A professional and well-experienced anesthesi-

ologist was in charge of the insertion of laryngoscope, for the experiment regards a body-invasive operation of inserting an endoscope through the nostril into the throat. Both the subjects have been informed the assessed risks and signed a consent letter to the experiment.

RESULT

Since the goal of this study was to compare the glottal configurations of the three types of Korean consonants in syllable-initial position, a standard for observation was set: The observation begins at a short period time before the consonant, and ends at somewhere after the vowel, and reference points were thus determined: (1) 60 ms before the oral release of the consonant; (2) the oral release of the consonant (a.k.a. plosive burst); (3) the mid point between the oral release of the consonant and the initiation of the vowel; (4) the initiation of the vowel; and (5) 60ms after the initiation of the vowel (as shown in Figure 3). Reference point 1 and 3 were marked by referring to the respective critical transitions on the spectrogram of the sound waves.

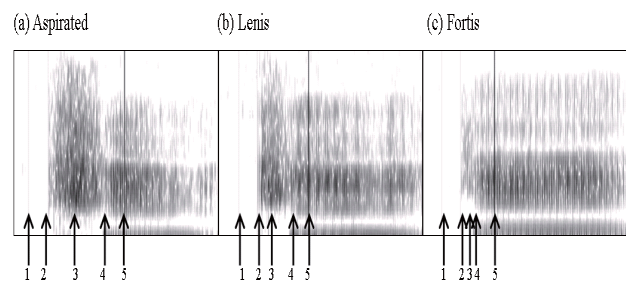


Figure 3
Spectrogram of the Acoustic Sound Waves of a CV Syllable, on which the Reference Points for Observation are Marked

The result shows that a systematic pattern is consistent across speakers and places of articulation; there is no distinguishable variation among different places of articulation, but a clear pattern emerges as a function of the three phonation types. Figure 4 contains a comparison of glottal configurations of the three types of plosives at one place of articulation (velum) for both subjects. The frame numbers in Figure 4 correspond to the reference points marked in Figure 3. In Figure 4, one can see that, generally speaking, the glottal opening is the smallest for the fortis type all the way through the five frames, and considerably larger for the other two types, while the aspirated type has slightly larger glottal opening than the lenis type. This is

consistent with the findings of previous works (Jun et al., 1998; Kagaya, 1974; H. Kim et al., 2005).

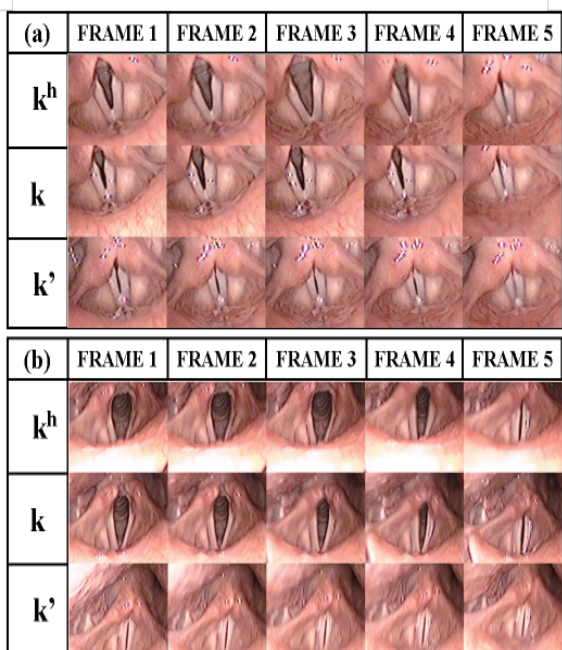


Figure 4
Glottal Configurations of /k^h, k, k'/ for Subject LLM (a) and SJH (b)

After closely scrutinizing the images of fortis consonants, the result revealed itself that there is at least a minimal opening between the glottal folds (Valve 1) and no observable engagement of Valve 2 in the first four frames of fortis consonants (Frame 5 represents characteristics of the vowel and is therefore exempted from evaluation). Figure 5 displays a comparison of the glottal state of the fortis type at Frame 2 (Figure 5a) and an exemplary case of glottalization (Figure 5b). The example of glottalization (Figure 5b) was extracted from an occasional instance of glottal insertion produced by the very same subject in the context of vowel-initial syllable.



Figure 5
A Comparison of Glottal State of Fortis Consonant (a) and that of Moderately Glottalized Utterance (b), Produced by Subject LLM

In Figure 5b, although one could see a very narrow slit in between the vocal folds (Valve 1), the obvious ad-

duction of ventricular folds (Valve 2) contributes to the formation of glottalization. Contrastively, in Figure 5a, the opening in between vocal folds (Valve 1) is a bit larger than that in Figure 5b, and the ventricular folds (Valve 2) are in rest position (no active control) rather than adducted (as in Figure 5b). Additionally, there isn't any activation of Valve 3 and Valve 4 in both images of Figure 5, showing that none of these two utterances pertains to the category of 'strong glottalization'. Thus, in terms of valves of the throat framework, the Korean fortis consonants that were investigated in this study have exhibited no trait of glottalization, not even slightly.

DISCUSSION AND CONCLUSION

In this study, we have examined the glottal images of the famous Korean three types of consonants, with a research focus on the relationship between the notion of 'fortisness' for fortis consonants and glottal configurations. Similar attempts had been made in previous studies a few decades ago. But, limited by the then technology, there was still room for discussion about whether glottalization exists in the production of Korean fortis consonants. In this study, with the help of the latest technology of laryngoscope and the most recent theoretical framework, we have been successfully documented the video images of glottal configurations of the three types of Korean consonants, and our data revealed that there is no observable glottalization during the production of the Korean fortis consonants.

The contribution of the current paper is threefold. First, it provides a full documentation of the glottal states of the three types of Korean consonants, which provides a good reference for future investigation into either diachronic or synchronic (dialectal) comparisons of Korean languages. Second, our findings reveal that 'glottalization' doesn't exist in our 25- to 35-year-old native Korean subjects' producing fortis consonants, as diverse from previous studies (Ogura, as cited in C.-W. Kim, 1970; Maddieson, 2005; Martin, 1951). This serves as the very piece of puzzle that links (and lends support to) the two most recent theoretical grounds that concerns the articulation of Korean fortis consonants: (1) the two-mechanism-view proposed by H. Kim et al. (2005), which associates the change in glottal adduction/abduction with acoustic consequence of VOT variation; and (2) the claim that the well-known three-way contrast in standard Korean sees an ongoing change in VOT realization (Silva, 2006b). Finally, the explicit descriptions and documentation of the operations of subglottal articulators for the three types of Korean consonants provided by the current study can help to improve the pedagogics for teaching Korean to L2 learners. According to the results of the current study, it would be improper to teach contemporary Korean by instructing the abstraction of 'fortisness' as 'constricted glottis', as one could have

been misled by the previously claimed association of fortis consonants and glottalization.

ACKNOWLEDGMENT

I would desire to express my greatest gratitude to Prof. Yueh-chin Chang, and Prof. Feng-fan Hsieh for precious advices throughout the paper, and Prof. Jerold A. Edmondson for detailed instructions of laryngoscopic technology and theories. Also, I wish to thank Doctor Yu-ren Peng for the technical supports in the experiments and Ting Huang for various supports in data processing. Without them, this study wouldn't have been done.

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