On Tensity of Korean Stops (Electropalatographic Study)*

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ABSTRACT

An Electropalatographic (EPG) study was made to investigate the articulatory distinction of three series of Korean stops according to tensity and the articulatory mechanism associated between tensity and coarticulatory effects. The results indicated that tensity of Korean stops is closely related to contact width and duration of complete closure, and that coarticulatory vocalic effects vary inversely with the degree of contact width and duration of complete closure.

Keywords: tensity, stops, coarticulatory, duration, EPG

1. Introduction

Special attention on Korean stops has been demanded by many phoneticians and linguists because they are classified into three series according to their tensity: 1) laxed, 2) aspirated, and 3) tensed.

Han & Weitzman (1970) measured voice onset time (VOT) for Korean stops using sonographic investigation. They concluded that VOT is the most useful acoustic parameter involved in the distinction of Korean stops.

Kim (1970) used cineradiography to measure the distance of the glottal opening in the production of the three series of Korean stops. He concluded that "aspiration is defined as a function of the glottal opening at the time of release of the oral closure of stop."

Hirose, Lee & Ushijima (1974) examined the intrinsic laryngeal muscle activity during the production of three series of Korean stops by use of an electromyography. They found that laxed stops involve less suppression of adductor muscles than the other two series of Korean stops. Also, tensed stops show an abrupt increase in thy- roarytenoid activity

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before the stop release.

Kagaya (1974) investigated the laryngeal gestures for three series of Korean stops by means of a fiberscope. His investigation of laryngeal gestures concluded similarly to the results of Hirose, Lee & Ushijima.

The above studies dealt with acoustic and physiologic distinction associated with Korean stops. Even though the articulatory distinction of Korean stops has considerable importance both in linguistic aspects and in applied aspects, it has been neglected for a long time.

The aim of this study is to provide the articulatory distinction of three series of Korean stops. Following this, an attempt will be made to show the articulatory mechanism associated between tensity and coarticulatory effects. EPG (Kay's Palatometer, Model 6300) is used for the characterization of Korean stops and their coarticulation studies. Since EPG is limited to the dental, alveolar, palatal, and pre-velar consonants, the Korean stops that are produced at the labial region [p, p^h, p'] and velar region [k, k^h, k'] are excluded from this study.

2. Experimental Method for Articulatory Distinction

As a native speaker of standard Korean, the author acts as the solo informant for this study. The EPG data for [t, t^h, t'] is carefully selected to eliminate coarticulatory effects from [t, t^h, t'] as much as possible. For example, the selected EPG data for [t, t^h, t'] are [tap] 'answer', [t^hap] 'tower' and [t'am] 'sweat'. The author with an artificial palate recorded the EPG data ten times in a fairly coarticulation-free context, "ki saram _____ paraponta", 'the man is watching _____'. Three recordings for each EPG data were selected based on the evenness of their tempo and whether the palatograms of the target segments at a point of maximum contact (PMC) are consistent and accurate.

3. Results of Articulatory Distinction

In order to characterize [t, t^h, t'], two measurements are taken: 1) contact width and 2) duration of complete closure.

Contact Width

The measurement of contact width can be described as the distance between a horizontal line running through the farthest front on-electrode of center line on-electrodes, and the horizontal line running through the farthest back on-electrode of center line on-electrodes. This measurement indicated in Figure 1 was taken from the palatograms for [t, t^h, t'] at PMC. Subsequently, the averages of contact width for [t, t^h, t'] were calculated and their order is represented in Table 1. The measurement is expressed in millimeters.

Figure 1. Contact Width

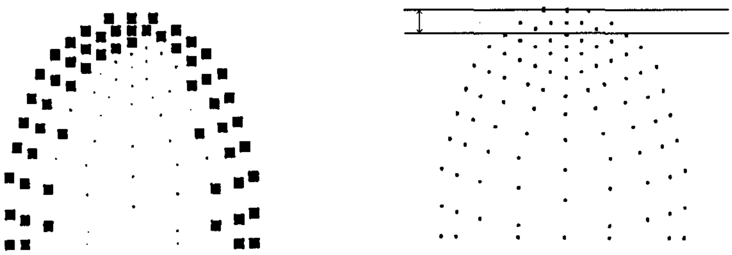


Table 1. Average and Order of Contact Width for [t, t^h, t']

Narrow	t	(5.0)
↕		
Wide	t^h, t'	(7.0)

As seen above, an increase in tensity is related to an increase in breadth of contact width for Korean stops [t, t^h, t']. This result is consistent with Kim (1965)'s experiment using a static palatography. However, the breadth of contact width is not an absolute parameter for distinguishing the three Korean stops [t, t^h, t'] because it is difficult to find a difference in the breadth of contact width between the aspirated stop [t^h] and the tensed stops [t'].

Duration of Complete Closure

The measurement of duration of complete closure is defined as how many complete, closed palatograms a target consonant has among sequential palatograms of a target consonant in the vicinity of PMC. Figure 2 shows six complete, closed palatograms of a target consonant [t] (0.73 through 0.78). The time increment between the contiguous palatograms is 10 msec. The average and order of duration for [t, t^h, t'] are given in Table 2.

Figure 2. Duration of Complete Closure

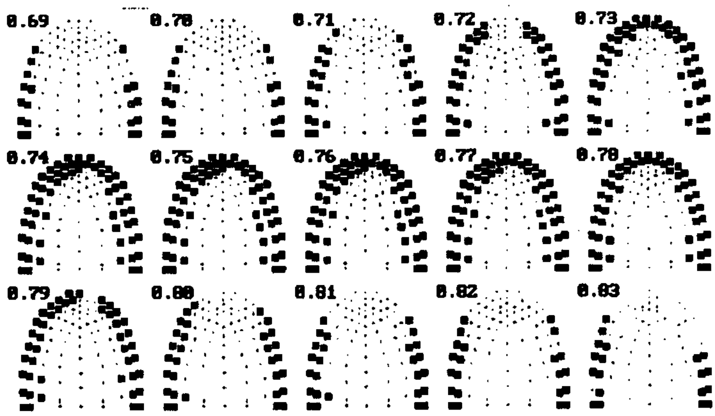


Table 2. Average and Order of Duration for [t, t^h, t']

Short	t	(6.3)
↕	t^h	(8.7)
Long	t'	(10.0)

The examination of the relationship between tensity and duration of complete closure suggests that time is more important as a parameter for distinguishing the target consonants [t, t^h, t'] than space.

4. Experimental Method for Coarticulation

To measure vocalic effects on [t, t^h, t'], three Korean vowels, [i, u, a], are arranged symmetrically as environments for the target segments [t, t^h, t']. For example, the EPG data for coarticulation are [iti], [it^hi], [it'i], [ata], [at^ha], [at'a], [utu], [ut^hu] and [ut'u]. The same procedures were repeated for the articulatory distinction of [t, t^h, t']. The measurements of contact width and duration of complete closure for [t, t^h, t'] in coarticulatory vocalic environments were compared with those in a neutral environment. Following this, the palatographic comparisons were shown. For the palatographic comparisons, the palatograms are represented using Gibbon's method (1990, 1991): ● indicates three time on-electrodes, ◍ indicates two time on-electrodes, ⊘ indicates one time on-electrode, and ⊙ indicates zero time on-electrode. These palatograms have boundaries drawn by linking the on-electrodes presenting at least two time on-electrodes.

5. Results of Coarticulation

The difference of two measurements (contact width, duration of complete closure) between [t, t^h, t'] in the neutral environment and [t, t^h, t'] in the coarticulatory vocalic environments can be provided as in the following tables. The symbol (-) or (+) indicates that the measurement of a target segment in the coarticulatory environment is below (-) or above (+) the average of a target segment in the neutral environment.

Table 3: Comparison of Contact Width

Order	:	[t]	=	[utu]	=	[ata]	>	[iti]
Average	:	5.0		5.0		5.0		1.8
Difference	:	0.0		0.0		0.0		-3.2
Order	:	[t^h]	=	[ut^hu]	>	[at^ha]	>	[it^hi]
Average	:	7.0		7.0		6.3		5.0
Difference	:	0.0		0.0		-0.7		-2.0
Order	:	[t']	=	[ut'u]	=	[at'a]	>	[it'i]
Average	:	7.0		7.0		7.0		5.0
Difference	:	0.0		0.0		0.0		-2.0

Table 4: Comparison of Duration of Complete Closure

Order	:	[t]	>	[utu]	>	[ata]	>	[iti]
Average	:	6.3		5.3		4.3		2.3
Difference	:	0.0		-1.0		-2.0		-4.0
Order	:	[t^h]	>	[ut^hu]	>	[at^ha]	>	[it^hi]
Average	:	8.7		8.0		6.7		5.7
Difference	:	0.0		-0.7		-2.0		-3.0
Order	:	[ut'u]	<	[t']	>	[at'a]	>	[it'i]
Average	:	10.7		10.0		8.0		6.7
Difference	:	+0.7		0.0		-2.0		-3.3

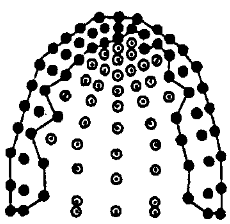
The above comparisons provide two very important pieces of information concerning coarticulatory vocalic effects on [t, t^h, t′]. First, [i] is found to be the strongest influencing vowel on the articulation for [t, t^h, t′]. In the [i] environment, each tensity of [t, t^h, t′] has been reduced compared to each tensity of [t, t^h, t′] in [a, u] environments. Second, an increase in the degree of tensity (laxed stop [t] < aspirated stop [t^h] < tensed stop [t′]) induces a decrease of coarticulatory vocalic effects. These findings are supported by the palatographic comparisons shown in Figures 3 - 5.

The palatographic comparisons suggest that coarticulatory vocalic effects on [t, t^h, t′] are found in the size of the central cavity. The size of the central cavity for [t, t^h, t′] in [i] environment is much smaller than the corresponding one [t, t^h, t′] in the [a, u] environments. These coarticulatory vocalic effects are caused by the fact that [i] is characterized as having a great number of on-electrodes distributed throughout the whole region of the artificial palate, while [a, u] are characterized as having only a few on-electrodes or no on-electrodes at all (see Figure 6) .

6. Conclusion

From the above experiments on [t, t^h, t′], it is found that tensity is closely related to contact width and duration of complete closure, and that coarticulatory vocalic effects vary inversely with the degree of contact width and duration of complete closure. Theses findings are consistent with Recasens' two rules of constraint (1983): spatial constraint and temporal constraint. Also, these findings can be applied to Korean bilabial stops [p, p^h, p′] and Korean velar stops [k, k^h, k′] to distinguish them. In conclusion, coarticulatory vocalic effects on Korean stops are the result of the co-occurrence of environment-independent and environment-dependent articulatory mechanisms.

Figure 3: Palatographic comparison between [t] in a neutral environment and [t] in coarticulatory vocalic environments



[t]

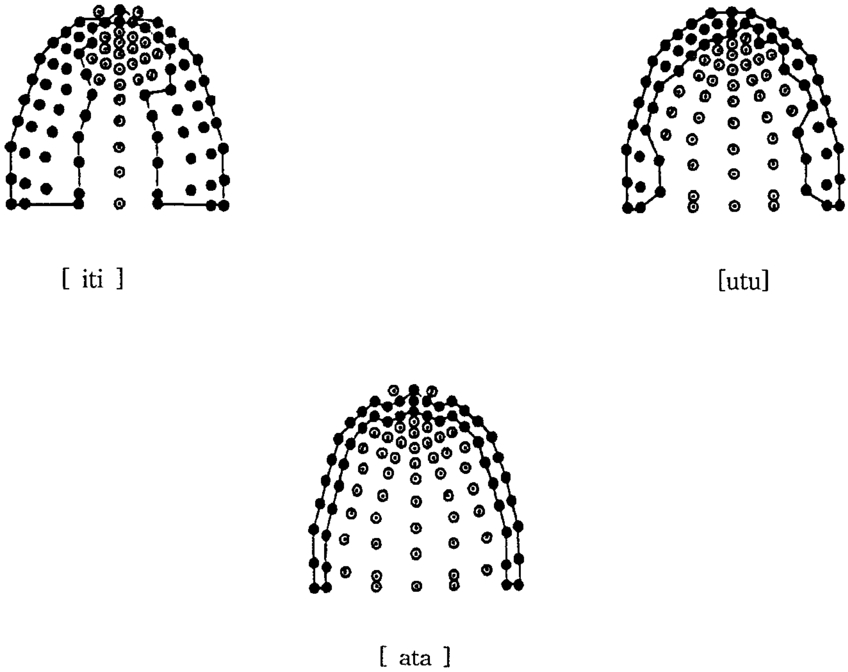
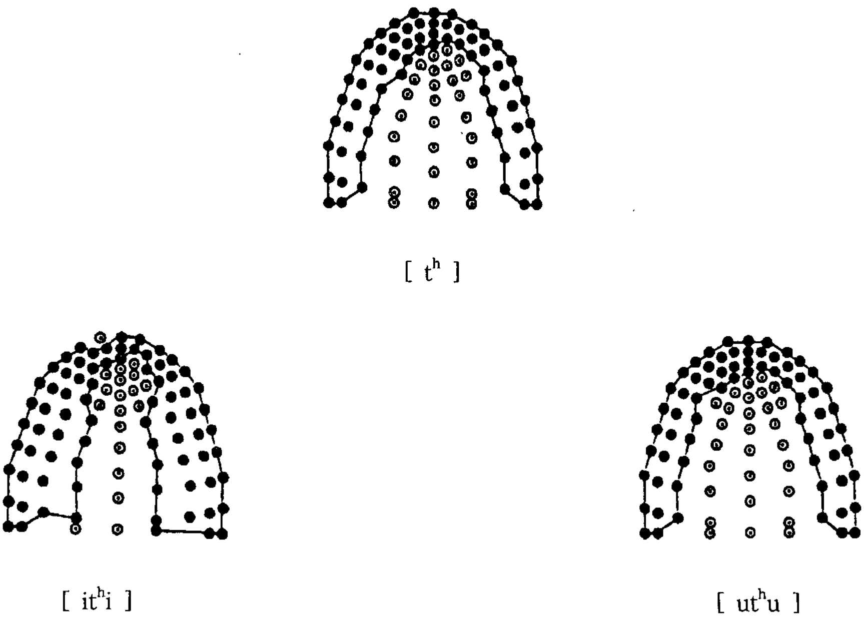
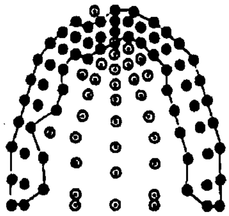


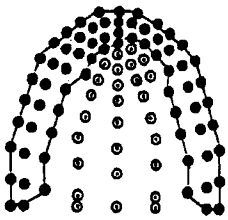
Figure 4: Palatographic comparison between [t^h] in a neutral environment and [t^h] in coarticulatory vocalic environments



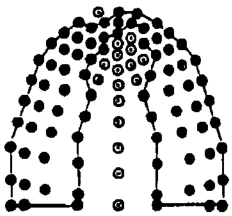


[at^ha]

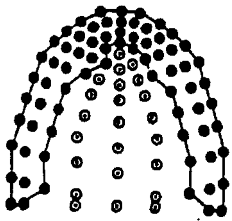
Figure 5: Palatographic comparison between [t'] in a neutral environment and [t'] in coarticulatory vocalic environments



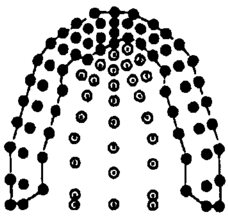
[t']



[it'i]

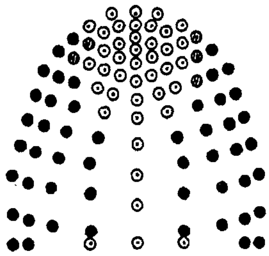


[ut'u]



[at'a]

Figure 6: Palatograms of [i, a, u] in a neutral environment.



[i]

No on-electrode

[u]

No on-electrode

[a]

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