Tensity in Obstruent Classification in Korean*

– Some experimental and theoretical considerations –

Sang-Cheol Ahn

1. INTRODUCTION

There has been a lot of controversy among linguists on the function of tensity, i.e., the question on whether the feature tensity is essential or redundant. This question has been treated as being related mostly with the differentiation of stops since stops show relatively clear distinctions.

In order to trace briefly the arguments made in the past, we may start with Stetson (1951:50) who preferred the fortis/lenis distinction. He states:

> Difference in pressure, expressed by the terms 'fortis and lenis' is more fundamental than the voicing of the consonants, and persists after the voicing distintion is lost . . .

Jakobson, Fant and Halle (1963: 38) list both tenseness and voicing as separate distinctive features and state as follows:

> Tense phonemes are articulated with greater distinctness and pressure ... The muscular strain affects the tongue, the walls of the vocal tract and the glottis. The higher tension is associated with a greater deformation of the entire vocal tract from its neutral position.

Kim (1965) conducted various experiments to discover a crucial function of tensity in stop classification and hence claimed as follows:

> The result is that the tensity feature has been found to be primary in Korean stops, and that tensity is independent of voicing and aspiration. It should be noted... that both tensity and voicing are autonomous cross-cutting features of stops. (1965: 357)

Not only Malécot (1970) but also Hardcastle (1973) confirm Kim's claim. For instance, Hardcastle states that:

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> It is suggested that a phonetic feature 'tensity' defined in terms of isometric muscular tension in the vocal cords and pharynx can usefully be employed to explain some of these properties. (1973: 263)

Catford (1970: 330) is somewhat doubtful about the status of tensity but he adds that:

> Recently, however, some evidence has been adduced for the existence of variations in articulatory muscular tension as an independent antrophonic and phonological parameter ....

In his dissertation, Sohn (1976) follows the theory on stops proposed by Kim, and Detrock (1977) also gets similar results by slightly different ways of experimentation.

Other scholars, however, have questioned the independent status of the tensity feature. Pike, for example, claims as follows:

> Fortis articulation entails strong, tense movements within the types of articulation... this norm cannot be delineated, but is a convenient friction as a basis for comparison. (1943: 128)

Ladefoged states :

> The label tense/lax has been used simply for convenience, and should not be interpreted as having a precise physiological meaning. (1964: 38-39)

Based on these earlier approaches, the purpose of this paper is to argue against the latter group of arguments and to expand the application of tensity to sibilant consonants as well as to stops. Those scholars, including Kim, who proposed tensity as a crucial feature made their experiments mainly on stops, not other consonants, but there are other consonants in Korean which also show the tense/lax opposition. Therefore, several experiments were conducted to provide some evidence, with special reference to Korean sibilants (and stops as well for comparison), that tensity has some phonetic meaning, that it is an automous feature, and that it is definable acoustically as well as physiologically. Through my experiments, it became more evident that tensity is the primary feature over voicing in the classification of Korean obstruents and that both tensity and aspiration are necessary cross-cutting categories in the obstruent classification in Korean.

2. EXPERIMENTAL METHOD

This investigation involves a detailed analysis of some acoustic and palatographic aspects of obstruents in Korean, spoken by a native speaker (the author).

At first, as was shown in Kim (1965, 1970) and Hardcastle (1973), there are three kinds of stops, usually described in the literature using the following labels:

TABLE 1. Three kinds of Korean stops

Type I : voiceless, unaspirated, tense : p', t', k'
Type II: voiceless, slightly aspirated, lax : p, t, k
Type III: voiceless, heavily aspirated, tense: p^h, t^h, k^h

On the other hand, there are also three kinds of sibilants in Korean, categorized as in Table 2:

TABLE 2. Three kinds of sibilants

Type I : unaspirated, tense : s', c'
Type II: slightly aspirated, lax : s, c
Type III: heavily aspirated, tense : c^h

The difference between Table 1 and Table 2 is that the latter includes both voiced and voiceless obstruents, since [c] is the voiced counterpart of the voiceless [s], while all of the obstruents in the former table are voiceless. Thus, in neither table, is voicing significant for the general classification of the three types, as the following experiments prove.

For investigating the obstruents, the corpus consisted of the following list of minimal triplets as well as minimal pairs differing in the initial position (Table 3 includes both sibilants and stops for comparison):

TABLE 3.	s'a - ta	'be cheap'
	sa - ta	'buy'

s'al	'rice'
sal	'flesh'
c'a - ta	'be salty'
ca - ta	'sleep'
c^ha - ta	'be icy'
t'al	'daughter'
tal	'moon'
t^hal	'mask'
k'i	'inkling'
ki	'flag'
k^hi	'length'

The experiments were carried out in two stages. The first stage was to obtain acoustic information during the informant's pronunciation of the test words. In order to achieve this, a Kay Elemetric Sonograph was used to produce wide-band spectrograms of the normal scale of 0-8,000 cps (each recording was followed by a calibration tone consisting of a short "pip" of square waves from a signal-generation set at a frequency of 500 cps), amplitude display graphs, and contour displays (0-8,000 cap). In the second stage, several test words containing sibilants were used to make palatograms. In order to do this, a polaloid palatoscope and films were used. After making the palatograms, I compared them with those of stops presented in Kim (1965: 353) in order to obtain a generalized aspect. The results of my experiments are attached separately in the appendix.

3. RESULTS

3.1. WIDE-BAND SPECTROGRAM

Figure 1 shows that greater and wider distribution of energy appears in the type I obstruent than in the type II obstruent. In other words, in [s'], the amount of distributed energy is more than twice that in [s], the lowest frequency is almost above 4,000 cps, and the upper limit of frequency exceeds 8,000 cps. Moreover, we can see a lower intensity in the vowel which follows [s], and pseudo-formants appear in the vowel following [s] due to the mixture of voicing of [a] and voicelessness of [s]. The average duration of [s'] is longer due to the long period of releasing tension.

TABLE 4. Duration differences (sec.)

s'	0.12	s'a	0.25
s	0.06	sa	0.17

Table 4 may show evidence of tensity, as was claimed earlier by Debrock:

> Of course, this correlate of the force of articulation is not the only one; the duration of the vowel itself of the consonant hold. (1977: 79)

However, this is a weak claim since, as we can see in Figure 2, vowel duration cannot be found in other cases.

Figure 2 shows that [c'] and [c^h] have higher intensity than [c], which appears as the darker mark level and the more sharply defined release. The aspiration of [c^h] consistently has a greater distribution of energy than in the case of [c]. The beginnings of higher formants of the vowel following [c] are often weaker than those following [c'] and [c^h]. Moreover, we can see that the beginning of the vowel following [c'] has a slower rate of vibration of the vocal cords. This fact is also shown in the contour displays.

3.2. AMPLITUDE DISPLAY

Figure 3 shows that more intensity is placed on [s'a] than in [sa]. Figure 4 shows that [c'a] produces the hightest intensity and [ca] produces the lowest one. Therefore, we can obtain the following data for relative strength of intensity:

TABLE 5.

	height of intensity (mm)	angular measure in the rising of vowel following sibilants (°)
s'a	35	84.5
sa	24	60.0

	height of intensity (mm)	angular measure in the rising of vowel following sibilants (°)
c'a	37	83.0
ca	23	70.0
c^{h}a	32	78.0

We can see that the vowel [a] following a Type I obstruent has the highest and the sharpest rise of energy, and that the lowest amplitude is placed at the beginning of the vowel following a Type II obstruent. Similar results are shown in Figure 5 and Figure 6 for stops, which are written in numerals in the following Table 6:

TABLE 6.

	height of intensity (mm)	angular measure in the rising of vowel following sibilants (°)
t'al	45	86.0
tal	28	79.5
t^{h}al	34	81.0
k'i	32	82.5
ki	18	79.0
k^{h}i	30	81.0

Notice that Type I has the highest amplitude both in stops and in sibilants.

3.3. CONTOUR DISPLAY

Figure 7 and Figure 8 show the same results as were discovered in the figures of wide-band spectrograms and amplitude display graphs. Moreover, contours show that a Type I obstruent is the most closely linked while a Type III obstruent is the least closely linked.

This phenomenon will be discussed later in this paper. The minimum lengths between the contours surrounding the darkest area and the lightest area in Figure 9 are shown in Table 7.

TABLE 7

	I s'a	II sa	I c'a	II ca	III $c^h a$
mm	1.5	6.5	1.5	4.0	7.5

Similar results are shown in Figure 10 for stops, which are written out in numerals in Table 8 :

TABLE 8

	I t'al	II tal	III $t^h al$
mm	1.5	4.0	8.0

3.4. PALATOGRAPHY

Palatograms, in Figure 11, reveal a similar fact to that shown in Kim (1965: 353) for alveolar stops. For Figure 11, all three subjects used in the experiments showed the narrowest contacts between the tongue and the roof of the mouth in the second series, as was (predicted) in Stevens (1960): [s] is produced with either the tip or the blade of the tongue raised up to the alveolar ridge, which can be confirmed by the contact area of palatograms. This result could be expected since the first series requires the strongest tension of the whole vocal tract and more closure by the tongue. This experiment was processed on triplets of affricates, but we can also predict that [s'] is produced with wide slit or groove (with a greater area of turbulence) as in [c'], while [s] and [c] make less contact.

4. DISCUSSION

The above experiment results show that the second series of sibilants has a stronger force of articulation (tensity) than that of the other two series. Thus, if we consider the results on stops by Kim (1965), we can make a better generalization that the second series of obstruents needs the strongest tension of articulation and the degree of the three series is II < III < I. Thre is no underlying voiced stop in Korean; the voiceless /p, t, k/ become voiced intervocalically. However, there exist both voiceless and voiced underlying segments in Korean sibilants which are fricatives and affricates, such as [s] and [c]. Therefore, if we consider sibilants as well as stops, it becomes more evident that tensity is the dominant feature over voicing. In other words, tensity has the primary function in the classification of obstruents, at least in Korean. Kim (1965: 342) did not discard the feature voicing in stops, but he added that:

> I will only claim that it is necessary to recognize both categories, tensity and voicing, for the precise description of stops, and that they are cross-cutting categories of noun; that is to say, neither the feature tensity nor the feature voicing is a universally primary feature over the other, but rather they are language dependent features.

Consequently, as was proposed by Kim and Hardcastle, tensity should be accepted as a phonetic as well as a phonological feature because tensity in Korean is a crucial feature which cannot be replaced by other features. Similar cases can be found in other languages such as French and Dutch proposed in Debrock (1977).

Now I will sum up the results of my experiments:

(1) More energy and higher intensity in the first series of obstruents were observed in the wide-band normal spectrograms.

(2) The wide-band spectrograms also showed a slower rate of vibration of the vocal cords and the amplitude display graphs showed lower amplitude at the beginning of the vowel following a Type II obstruent.

(3) The amplitude display graphs further showed that the vowel following a Type I obstruent has the highest and the sharpest rise of energy by the release of the strong tension of the obstruent.

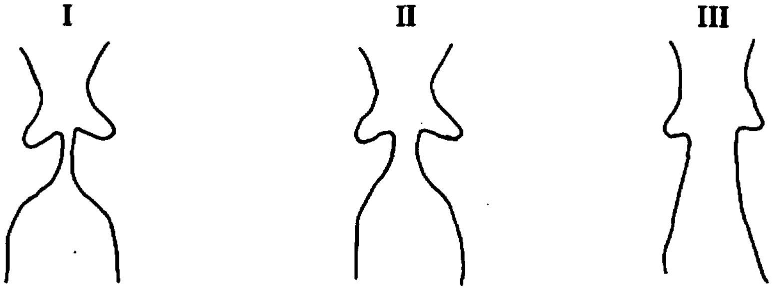
(4) The sharp rise of energy can be also observed in the contour displays which show wider distance among contour lines in the beginning parts of the vowels following Type II, not I, obstruents.

(5) Palatograms of mine as well as Kim's show the narrowest contact between the tongue and the roof of the mouth in the second series and the widest contact in the first series of obstruents.

In Figures 8, 9 and 10, contour displays show that I has the most closely linked obstruents and II has the least closely linked ones since the distances among contour lines in the first series of sibilants are shorter than those of other series. This concept "degrees of linking" was proposed by Skaličkava (1960: 14-15) but it was objected to by Kim (1965: 345) on the grounds that it can be replaced by the concept "degrees of aspiration". However, what the contour displays show here can be explained in that the vowels following Type I have a sharper rise of energy than those following Type II or III obstruents, indicating that the first series of obstruents have the highest intensity. Similar results are also shown in Figure 10 for stops.

Although I could not make experiments on the degree of glottal opening as shown for stops in Kim (1970), the expected results would be similar; that is, the first series would show the narrowest opening and the third series would show the widest opening due to aspiration which requires wide glottal opening. Thus we may make three generalized figures similar to those in Kim (1970: 110):

Figure 12. Three kinds of glottal openings,



Here, we can say, from a purely theoretical point of view at least, that II is close to the neutral shape of vocal cords and I is a constricted shape of the vocal cords, which requires more tensity than the other two. Here, we may quote Chomsky & Halle (1968: 315):

> Glottal constrictions are formed by narrowing the glottal aperture beyond its neutral position.

Similarly, we may observe that III has stretched vocal cords also requiring more tensity than in II.

Now, by the use of the feature tensity, we can arrange the Korean obstruents as follows:

TABLE 9. Three types of Korean obstruents.

I	II	III
p'	p	p^h
t'	t	t^h
k'	k	k^h
s'	s	
c'	c	c^h

In Table 9, there is a gap in III, which may be assumed to be [s^ha]. This gap is systematic, not accidental, and we can postulate several possible reasons for this gap. First, [s^h] is not easy to pronounce physiologically since [s] has a similar amount of air-flow to that of [c^h] which is the maximum air-flow for distinctiveness for Koreans. This reason is a purely theoretical and a hypothetical consideration.

Second, [s^h] is not necessary because there is no significant distinction between [s^h] and [s] perceptually, especially for Koreans. Moreover, /c^h/ itself is different from /c'/ or /c/ underlyingly since /c^h/ is voiceless, while the others are voiced. Thus Korean does not need to fill up this gap which does not affect the distinctiveness in meaning.

On the other hand, we can also generalize that many obstruents alternate with other homorganic obstruents to vary the degree of intensity in expression. Kim (1965:356) presented several examples of stops and I will offer several other examples which are not stops:

TABLE 10.

II		I	III
se-	‘to be strong’	s'e-	
sallaŋ	sallaŋ ‘to rustle’	s'allaŋ s'allaŋ	
cuk	‘shape of drooping’	c'uk	c^huk
cuŋəl	cuŋəl ‘to murmur’	c'uŋəl c'uŋəl	

II	I	III
cɛŋcɛŋ 'distinguished'	c'ɛŋc'ɛŋ	
cullən cullən 'shape of tossing and leaping'		c^hullən c^hullən

The intensified expressions are either I or III, or both.

5. CONCLUSION

The purpose of this paper was to discover tensity as a primary feature in the classification of sibilants and to make a generalization that it has the primary function in the classification of Korean obstruents since several scholars such as Kim (1965) and Hardcastle (1973) proposed tensity as a crucial feature in the classification of stops only. The result is that tensity is a primary feature over voicing in Korean obstruents. Moreover, the results of palatograms show that tensity is not confined to the glottis, but also present in the rest of the vocal tract.

At present it seems that tensity is independent of aspiration. As tensity is not so distinctive between II and III and the significant difference between the two series is the difference in aspiration, aspiration may not be replaced by the tense/lax opposition and hence tensity should be independent of aspiration and dominant over voicing.

Although tensity is not a universal primary feature in obstruent classifications since it is significant only for several languages including Korean, we should not ignore the importance of this feature. To do so would be to leave out an element important to phonetic theory, as pointed out by Kim (1965: 358-59):

> Any general phonetic theory, or a part of it, like the one proposed by Lisker and Abramson, which does not reflect this fact and which makes generalizations violating the phonetic realism of any known living language, say Korean or Japanese, is an oversimplified theory, ... a generalization can be made even when there are a few exceptions to that generalization, but a theory of universals must not be invalidated by the diversity of languages.

APPENDIX

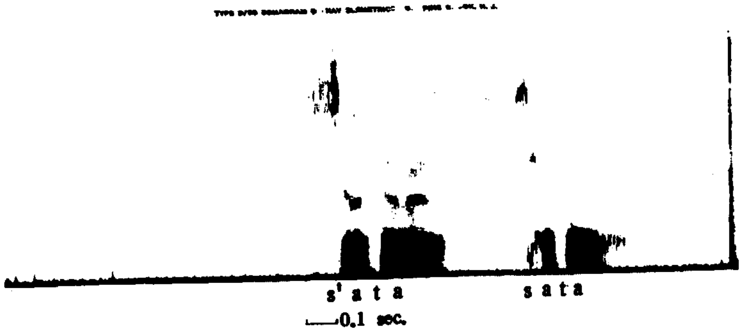


Figure 1.

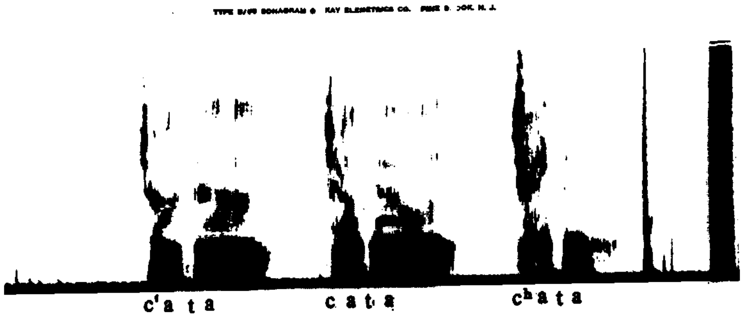


Figure 2.

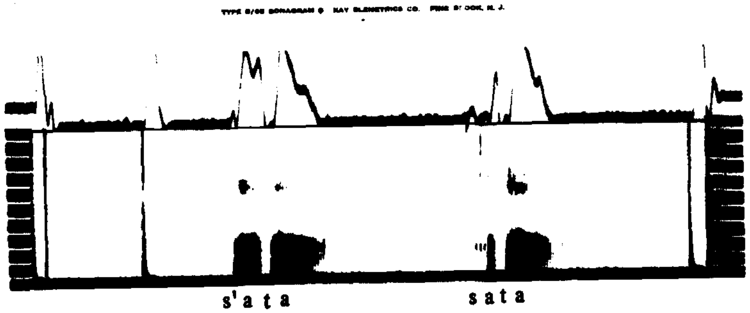


Figure 3.

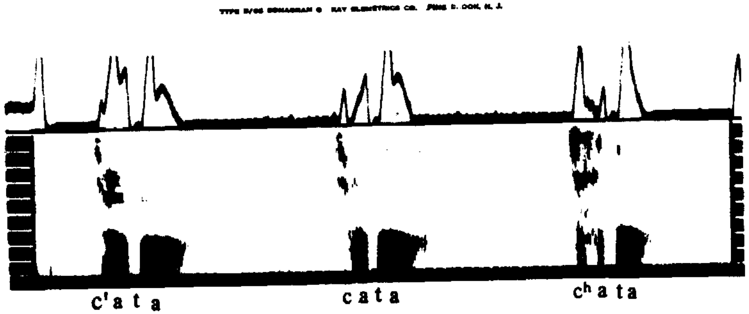


Figure 4.

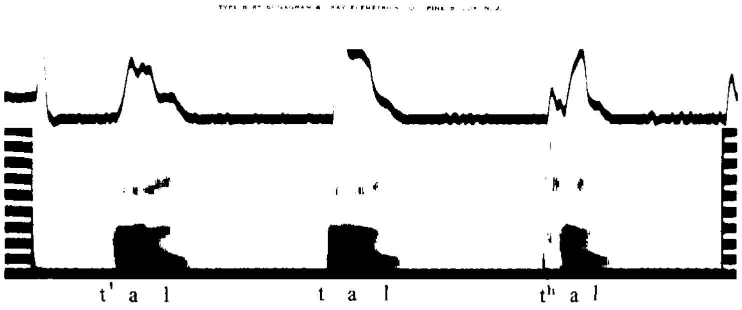


Figure 5.

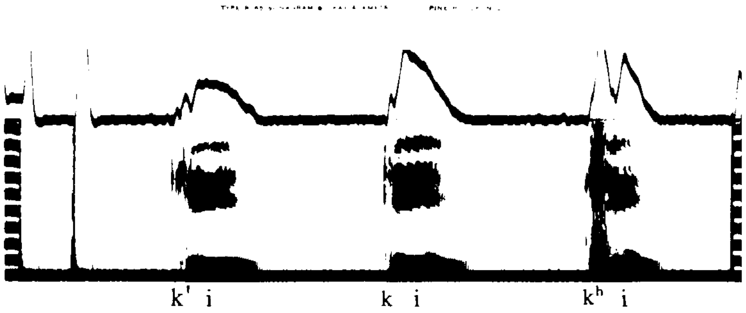


Figure 6.

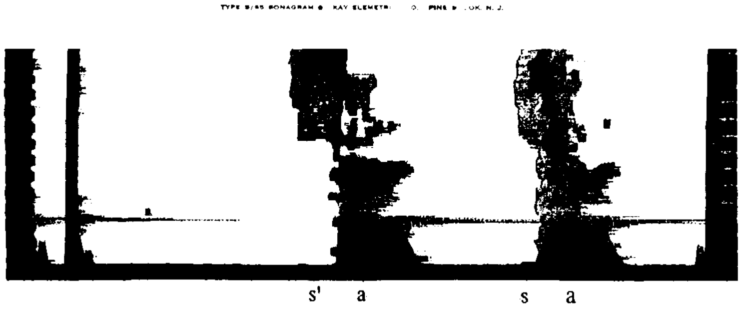


Figure 7.

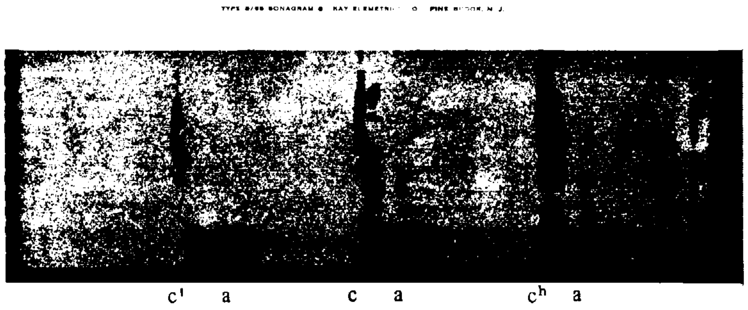


Figure 8.

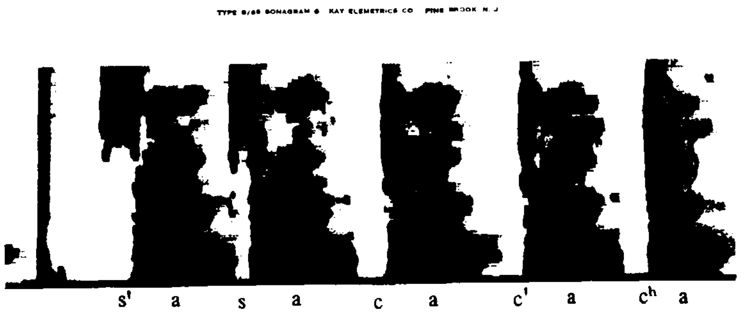


Figure 9.

Figure 10.

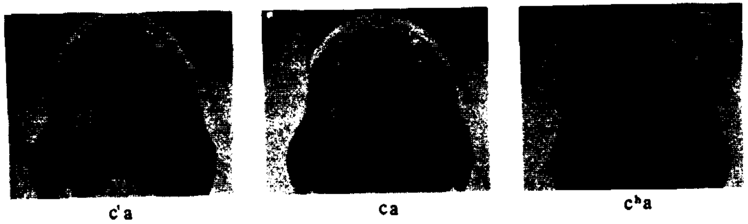


Figure 11.

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Department of English
College of Liberal Arts and Sciences
Kyung Hee University