

Tense Consonants in Korean Revisited: A Crosslinguistic Perceptual Study*

Charles B. Chang

University of California, Berkeley / University of Cambridge

The well-described laryngeal system of Korean has most often been analyzed as a typologically unique contrast among three kinds of voiceless plosives: aspirated, lax, and tense. This paper focuses on the phonetics of the tense series by examining the perception of obstruents described as tense in Korean and as voiceless unaspirated in Chinese, Spanish, and English in an experiment with 32 native Korean speakers. In a native/non-native labeling task, subjects were unable to distinguish between Korean syllables beginning with tense obstruents and Chinese syllables beginning with voiceless unaspirated obstruents of the same place of articulation; similar data holds for many of the Korean vs. Spanish and Korean vs. English syllable comparisons as well. These results suggest that, in word-initial position, tense Korean consonants are not perceptibly different from the voiceless unaspirated consonants of these other languages.

1 INTRODUCTION

The three-way laryngeal contrast in Korean plosives has been described in various ways in previous linguistic studies (e.g. Lisker and Abramson 1964; C.-W. Kim 1965, 1970; Han and Weitzman 1970; Abberton 1972; Hardcastle 1973; Kagaya 1974; Hirose et al. 1974; Dart 1987; Silva 1992; M.-R. Kim 1994; Han 1996; Cho and Keating 2001; Cho et al. 2002; Choi 2002; Park 2002; M. Kim 2004). The majority of these analyze the contrast as one between three series of phonologically voiceless plosives: aspirated, lax, and tense,¹ which have traditionally been transcribed as, respectively, /p^h, t^h, k^h/; /p, t, k/; and /P, T, K/, /p', t', k'/, or /p*, t*, k*/. Even when transcription conventions make use of symbols traditionally denoting voiced sounds to represent the lax plosives (which are voiced intervocally), the analysis of the laryngeal contrast usually assumes voicelessness in underlying representations. For instance, the transcription conventions of Lee (1999), which are used in many other studies of Korean, uses /b, d, g/ to indicate 'voiceless unaspirated (or slightly aspirated) lenis plosives'.²

However, Kim and Duanmu (2004) have argued that the analysis of the Korean laryngeal system as having three kinds of voiceless consonants is problematic for phonological theory because, among other reasons, having to describe a 'tense' series that is distinct only in Korean (e.g. by positing a feature [tense]) overgenerates such unattested sounds as /b^{h*}/ and /p^{h*}/.

Kim and Duanmu propose instead that the Korean

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¹ These laryngeal series have acquired a variety of other names in the literature. The aspirated series has also been called 'heavily aspirated', 'strongly aspirated', and 'super aspirated'; the lax series, 'lenis', 'weak', 'plain', 'slightly aspirated', and 'breathy'; and the tense series, 'fortis', 'strong', 'glottalized', 'long', 'unaspirated', and 'forced'. In this paper they will be referred to as aspirated, lax, and tense, respectively

² See also Lee (1996), in which the lax series is transcribed word-initially as /b̥, d̥, g̥/.

laryngeal contrast is more accurately characterized as one between voiceless aspirated, voiceless unaspirated, and voiced plosives (which are devoiced word-initially).

Leaving aside an analysis of Korean lax stops, the present study focuses on the nature of the so-called tense series. Word-initially this series is distinguishable from the other two along a number of dimensions (e.g. linguopalatal contact, glottal configuration, subglottal and intraoral pressure, laryngeal and supralaryngeal articulatory tension, voice onset time, fundamental frequency and first formant onset, intensity buildup, and voice quality), with the much shorter voice onset time (VOT) being the main cue (cf. M. Kim 2004). However, impressionistically the Korean tense consonants are very similar to the voiceless unaspirated consonants of many other languages. Non-Korean speakers usually find it very difficult to perceive a difference between Korean tense consonants and their language's voiceless unaspirated consonants. Thus, the main question posed here is the extent to which Korean speakers themselves can perceive a difference. Does the Korean tense series actually differ perceptually from voiceless unaspirated consonants in other languages? If so, what are the main cues to 'tenseness'?

The present study adopts a comparative approach to this question via a perception experiment using stimuli from Korean and a variety of other languages. The experimental methods are first described, followed by presentation of the perceptual data. The results are then discussed in terms of their implications for the analysis of Korean tense consonants and for feature theory in general.

2 PERCEPTION EXPERIMENT

2.1 Stimuli

The stimuli recorded for this experiment came from Korean, Mandarin Chinese, Spanish, and English. A word list of monosyllabic Chinese stimuli was constructed such that the two-way laryngeal contrast between voiceless unaspirated and voiceless aspirated plosives and affricates occurred before the three vowels /a, i, u/ and, wherever possible, on Tone 4 (the 51 falling tone). A similar monosyllabic word list was constructed of Korean stimuli displaying the three-way laryngeal contrast, with the first syllables of multisyllabic words being used where no common monosyllabic words were available. Similar word lists of Spanish and English stimuli containing voiced and voiceless plosives and affricates were constructed as well, but in these latter cases, since many of the words were polysyllabic, the respective speakers were instructed to pronounce them with pauses between syllables so that the syllables of interest could be easily isolated later. Finally, in the case of monosyllabic English stimuli, the speaker was also instructed not to pronounce any coda consonants. In this way, all stimuli that were later used in the perceptual experiment were recorded as open monosyllables. In addition, for the English words beginning with #sC- clusters, the initial [s] was removed to produce stimuli with no audible consonant cluster. These words were included to add word-initial voiceless unaspirated plosives to the English stimulus pool.

The Korean word list was recorded by three native speakers of Seoul Korean, one male and two females in their mid-20s and early 30s from Seoul. The Chinese word list was recorded by three native speakers of Mandarin Chinese, one male and two females drawn from the same age group. The female Chinese speakers were from Changchun and Taiwan, while the male Chinese speaker was from Hong Kong. The Spanish word list was recorded by a native speaker of Argentinean Spanish, a 19-year-old female from Buenos Aires. Finally, the English word list was recorded by a native speaker of American (Californian) English, a 20-year-old female from Los Angeles. For all stimuli, three tokens were collected in isolation, recorded as mono sound files in Praat 4.2.17 on a Sony Vaio PCG-TR5L laptop computer using a Shure C608 microphone.

Once the items on the word lists were recorded, they were first encoded as WAV files in Praat and then normalized for pitch contour and intensity in order to prevent subjects from making judgments based upon cues from pitch or intensity rather than consonants and vowels. All the pitch contours were standardized via the pitch manipulation functions in Praat as falling over the same slope of Hz/sec following the pitch peak, resulting in most stimuli having a pitch drop of approximately 100 Hz over their duration. Intensity of each recording was scaled in Praat to an average value of 70.0 dB. Second, the initial voice pitch of the sound files recorded by a given speaker was made to vary within the range of 150-350 Hz in intervals of 10 Hz via Praat's 'Shift pitch frequencies' function, resulting in a graded continuum of the same sound with the same original pitch contour beginning at several different onset values. This manipulation was performed basically to create the impression that there were many more than eight speakers. In this way, subjects were prevented from separating out the speakers on the sound files using overall voice pitch and then making perceptual judgments based upon the speaker (according to their initial judgment for that speaker), rather than based upon the actual stimulus. A perceptual test was then constructed mixing 220 stimuli: 30 stimuli from each of the three Korean speakers, 23 stimuli from each of the three Chinese speakers, 25 stimuli from the Spanish speaker, and 36 stimuli from the English speaker. A short pretest containing six filler stimuli was conducted prior to the actual test as a trial run to familiarize the subject with the test procedure.

2.2 Subjects

A total of 34 subjects participated in the perception experiment. Subjects were all native Korean speakers, 14 males and 20 females in their 20s and 30s who spoke various dialects (mostly from Seoul or Gangweon-do to the east of Seoul). None reported any hearing disorder or history thereof. In the end, two female subjects who spoke the Gyeongsang-do dialect were excluded because of the different nature of tense consonants and phonological tensification in this dialect vis-à-vis the Seoul dialect. Thus, the results discussed below are based on data from a total of 32 subjects.

2.3 Procedure

Subjects were asked to take a test in which they were to judge if a speaker was a native Korean speaker or not. They were presented with stimuli individually via Praat's listening test function, on a Sony Vaio PCG-TR5L laptop computer over Direct Sound EX-29 noise reduction headphones. They had to click a box labeled 'YES' (in English) on the computer screen if they thought the stimulus was recorded by a native Korean speaker or a box labeled 'NO' if they thought the speaker did not sound native. They were instructed that they could only listen to each stimulus once, that they would not hear the following stimulus until they made a decision about the current one, and that they could not go back to a previous stimulus. Stimuli were presented in a different random order to all subjects. The perceptual test lasted approximately 15 minutes in all, and subjects were compensated the equivalent of USD 5.

2.4 Results

2.4.1 Korean vs. Chinese

The data for subjects' perceptual judgments on Korean tense plosives vs. Chinese voiceless unaspirated plosives is given in tables 1-8 below. A 'YES' judgment that a speaker was native was recorded as a '1', while a 'NO' judgment was recorded as a '0'.

The tables below show the totals of native ‘YES’ judgments of all 32 subjects for the three speakers in the two language groups; the mean scores for the two language groups across 32 subjects; the respective standard deviations; and p-values for the correlation.³

Table 1 compares subjects’ responses to Korean and Chinese labial plosives. In all cases $p > 0.05$, indicating that the differences between the totals of native judgments for Korean vs. Chinese are not statistically significant (note that the syllables /ki/ and /gi/ are absent from present-day Mandarin Chinese, so only two comparisons of velar-initial syllables are shown below).

Comparison	Korean	Chinese	Diff.	p
Korean [p*a] vs. Chinese [pa]	27	37	-10	> 0.05
Korean [p*i] vs. Chinese [pi]	31	28	+3	> 0.05
Korean [p*u] vs. Chinese [pu]	29	28	+1	> 0.05
Korean [t*a] vs. Chinese [ta]	34	30	+4	> 0.05
Korean [t*i] vs. Chinese [ti]	22	22	0	> 0.05
Korean [t*u] vs. Chinese [tu]	23	27	-4	> 0.05
Korean [k*a] vs. Chinese [ka]	33	44	-11	> 0.05
Korean [k*u] vs. Chinese [ku]	30	30	0	> 0.05

Table 1

‘Yes, native Korean’ responses to Korean and Chinese plosives

In the case of the alveopalatal affricates the results are more mixed. Since the alveopalatal affricate does not occur immediately before the vowel /u/ in Mandarin Chinese, only two comparisons are available. For the comparison of Korean [tʃ*a] vs. Chinese [tʃia], the p-value is again well over 0.05, indicating no significant differences in the native judgments for Korean vs. Chinese. On the other hand, there is a significant difference between the judgments for Korean [tʃ*i] vs. Chinese [tʃi], as seen in table 2.

Comparison	Korean	Chinese	Diff.	p
Korean [tʃ*a] vs. Chinese [tʃia]	16	12	+4	> 0.05
Korean [tʃ*i] vs. Chinese [tʃi]	15	48	-33	< 0.001

Table 2

‘Yes, native Korean’ responses to Korean and Chinese affricates

This difference might be attributed to exceptional features of the first and second Korean speakers’ [tʃ*i] recordings. In the first speaker’s recording, there is a great deal of creakiness, while in the second speaker’s recording, the vowel is much lower than the vowels of the other speakers—closer to [ɪ] than [i]. These characteristics of the speech samples are likely responsible for the significantly lower ratings for these speakers’ recordings as compared to those for the third Korean speaker and the Chinese speakers.

In the case of the coronal fricatives, the results are again a little mixed. For Korean [s*a] vs. Chinese [sa] and Korean [ç*i]⁴ vs. Chinese [çi], $p > 0.05$, indicating no significant differences in the native judgments for Korean vs. Chinese. However, in the

³ Thus, the maximum total is 96 (32 subjects x 3 possible native judgments for the speakers within the language group).

⁴ The alveolar fricative [s] does not occur before the vowel /i/ in Korean, as the high front vowel induces palatalization of the alveolar to [ç].

case of Korean [s*u] vs. Chinese [su], there is a significant difference in judgments, as seen in table 3.

Comparison	Korean	Chinese	Diff.	p
Korean [s*a] vs. Chinese [sa]	22	15	7	> 0.05
Korean [ç*i] vs. Chinese [çi]	31	39	-8	> 0.05
Korean [s*u] vs. Chinese [su]	34	15	19	< 0.01

Table 3

‘Yes, native Korean’ responses to Korean and Chinese fricatives

The difference perceived between Korean [s*u] and Chinese [su] may be attributed to the consistent acoustic differences between the Korean and Chinese vowels: while the Korean vowels start off relatively low, between [ʊ] and [u], and maintain steady formants throughout their articulation, the Chinese vowels start off fairly central before gliding into a high [u]. Thus, the cues particular to the Chinese vowels were most likely used by subjects to pick out the Chinese samples from the Korean.

2.4.2 Korean vs. Spanish, Korean vs. English

Since only one token of the Spanish and English words was included in the perceptual test as compared to three each of the Korean and Chinese words, the same statistical analyses cannot be given for the Korean vs. Spanish and Korean vs. English judgments. Nonetheless, some similarities can be seen where vowel differences do not ‘give away’ the non-nativeness of the speaker. In the case of Spanish, there are many cases in which the Spanish sample is given ratings similar to the Korean samples. Some examples are shown in table 4 (K = Korean speaker, S = Spanish speaker).

Comparison	K1	K2	K3	S
Korean [t*i] vs. Spanish [ti]	10	6	7	11
Korean [t*u] vs. Spanish [tu]	8	8	9	7
Korean [k*a] vs. Spanish [ka]	9	11	13	11
Korean [k*i] vs. Spanish [ki]	14	6	12	13
Korean [s*u] vs. Spanish [su]	5	18	12	12

Table 4

‘Yes, native Korean’ responses to Korean and Spanish stimuli (by speaker)

Likewise, there are several examples of an English sample being given ratings similar to the Korean samples, as seen in table 5 (E = English speaker).

Comparison	K1	K2	K3	E
Korean [p*a] and English [pa]	7	10	12	9
Korean [p*i] and English [pi]	9	15	8	14
Korean [t*i] and English [ti]	10	6	7	10
Korean [k*a] and English [ka]	9	11	13	15

Table 5

‘Yes, native Korean’ responses to Korean and English stimuli (by speaker)

These data suggest that those Spanish and English samples in which the foreign vowel is not strikingly different from the Korean vowel sound no less native to Korean speakers than actual Korean samples.

2.5 Summary

In short, subjects were found to be unable to reliably distinguish between Korean tense obstruents and Chinese voiceless unaspirated obstruents of similar places of articulation. In some cases they chose in favor of the Korean samples and in other cases in favor of the Chinese samples, but in nearly all cases there was no statistical difference between the judgments made in favor of the Korean samples and the Chinese samples, indicating that subjects were basically guessing when making their judgments. These results suggest that there is no phonologically significant laryngeal difference between Korean tense plosives and voiceless unaspirated plosives in a language like Chinese, for it would be difficult to explain how, for instance, an imperceptible laryngeal gesture could come to be acquired by a child learner of Korean.

3 DISCUSSION

Some points about the experimental methodology and design should be addressed before the implications of these results are discussed in further detail. First, it is not obvious that the nature of the experiment was such that subjects could even make the judgments asked of them in the first place. In other words, was the task simply too difficult? What about subjects' general tendency to label samples as non-native, even the native ones? The many cases in which subjects distinguished between the native sounds and non-native sounds relatively easily (due to, e.g., vastly different vowel qualities, robust voicing during a stop closure, or prenasalization of a stop) would seem to indicate that the task itself was not too difficult. Instead, the data patterns seen above seem to arise from genuine perceptual similarity between the Korean and non-Korean sounds. Furthermore, there is no reason to think that the general negative response bias affected the judgments of the native and non-native samples in any way but equally. In fact, a highly positive response bias would actually have been worse because of the ceiling effect: there would have been no way to tell if the Korean sounds or the non-Korean sounds had been perceived as more native-like.

However, it is not clear that subjects were only attending to consonantal and vocalic cues in making their judgments. Certainly, they could have interpreted the task of choosing native-sounding speakers as one of choosing pleasant-sounding speakers—in other words, judging how well the speakers matched up with some prototype of a native speaker the subjects had in mind (or perhaps two, one male and one female). This prototype phenomenon most likely did have an effect on the judgments for a few samples. In the case of a sample that might have sounded strange in one way or another—very creaky on the low end of the pitch manipulation range (cf. §2.4.1, table 2) or like they were recorded in falsetto voice (i.e. the low-voiced Korean male speaker's samples on the high end of the pitch manipulation range)—subjects tended to give more non-native ratings as compared to their ratings of the same sounds pronounced by other speakers within their respective language groups. Nonetheless, there are very few samples of this sort, so it is highly unlikely that they altered the statistical (in)significance of the final results.

Finally, it is possible that the results may simply point to adult speakers' loss of perceptual distinctions that are not important in their language. Maybe there is in fact a laryngeal difference between the Korean tense obstruents and the non-Korean voiceless unaspirated obstruents, but the difference is not perceptible to adult Korean speakers (or

to adult speakers of other languages, as mentioned in the introduction) because the distinction is of no phonological significance. It should be noted, though, that if it were the case that babies attended to this distinction, the typological expectation would be that some language would make use of this distinction in their phonological inventory. As such a language has yet to be discovered, we must assume the null hypothesis that such a distinction does not exist.

It appears, then, that the results of this study support the identification of tense plosives with voiceless unaspirated plosives: they are two ways of describing the same thing. At this point, it becomes relevant to examine Kim and Duanmu's (2004) arguments against the feature [tense]. They raise the issue that Korean's system of three kinds of voiceless plosives seems to be found in no other language, and as mentioned above, they illustrate the overgeneration problem that results from having to describe this typologically unique system via the addition of a feature [tense] or another level of voicing/aspiration: the coexistence of the features [tense] and [voiced] wrongly predicts the existence of the unattested sounds /b^{h*}/ and /p^{h*}/. They solve this problem by simply getting rid of the feature [tense] and analyzing the Korean lax stops as [+voiced]. However, it is equally possible to resolve this issue by replacing the feature [voiced] with the feature [tense]. In either the former or the latter case, the hypothetical phoneme /b^{h*}/ could not exist by virtue of the fact that the features [tense] and [voiced], which would both have to be present in its featural specification, do not coexist in the universally available pool of phonological features.

On the other hand, the status of /p^{h*}/ can be explained in a different way. As concluded above, tense plosives and voiceless unaspirated plosives refer to the same entity. If this conclusion can be expanded to voiceless sounds in general, then the equivalence of phonologically tense plosives and phonologically voiceless plosives accounts for the status of /p^{h*}/: the sound actually does exist, but is a notational variant of the more familiar /p^h/, specifying redundant information.

4 CONCLUSION

This study examined consonants described as tense in Korean and as voiceless unaspirated in Chinese, Spanish, and English in an effort to investigate the difference between these two categories. The results of a perception experiment with native Korean speakers suggested that tense Korean consonants are not perceptibly different from the voiceless unaspirated consonants of these other languages, implying that a feature system containing both [tense] and [voiced] is largely redundant.

As for next steps, more data needs to be collected to confirm that the confusion pattern found in this study holds for speakers not only in the aggregate, but individually as well, and for gradient judgments as well as binary judgments. In addition, the data must show positive trends (e.g. a statistically significant correlation/difference) instead of the negative evidence (lack of a statistically significant difference) found in this study, since it is possible that some factor not accounted for, rather than perceptual similarity, led to the identity in perceptual judgments observed here. In addition, a comparative articulatory study of 'tense' vs. 'voiceless unaspirated' consonants from different languages would help to show that the similarity in perception corresponds to similarity in the state of the larynx. Finally, more evidence is needed to show whether a paradigm shift from [voiced] to [tense] should be incorporated into current linguistic description. These are undertakings left for future research.

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Charles B. Chang

University of California, Berkeley
 Department of Linguistics
 1203 Dwinelle Hall MC#2650
 Berkeley, CA 94720
 USA

cbchang@post.harvard.edu
<http://socrates.berkeley.edu/~cbchang>