

DOCUMENT RESUME

ED 382 038

FL 023 041

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 TITLE Korean "Tense" Consonants as Gemimates.
 PUB DATE 95
 NOTE 15p.; For complete volume, see FL 023 039.
 PUB TYPE Reports - Research/Technical (143) -- Journal
 Articles (080)
 JOURNAL CIT Kansas Working Papers in Linguistics; v20 p25-38
 1995

EDRS PRICE MF01/PC01 Plus Postage.
 DESCRIPTORS Comparative Analysis; *Consonants; *Korean;
 *Phonetics; *Phonology; Structural Analysis
 (Linguistics); *Tenses (Grammar); Uncommonly Taught
 Languages
 IDENTIFIERS *Gemimates

ABSTRACT

This paper argues that Korean "tense" consonants are gemimates based upon phonetic as well as phonological evidence. In section 2, the phonetic realization of tense consonants is discussed and compared with the phonetic realization of plain consonants. Section 3 looks at the representation of Korean tense consonants as single segments. Section 4 focuses on the representation of Korean tense consonants as gemimates and show that they are more appropriately represented as gemimates than as single segments. In section 5, the phonetic realization and phonological representation of Korean tense consonants are summarized. Contains 16 references.
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KOREAN "TENSE" CONSONANTS AS GEMINATES

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Abstract: In this paper, I argue that Korean "tense" consonants are geminates which occupy two C positions in a CV-tier. This argument is supported by phonetic evidence such as a longer closure duration of the tense consonants and phonological evidence such as the distribution, integrity, and inalterability of Korean tense consonants as well as the accent placement rule which is sensitive to syllable weight in Korean.

I. Introduction

Korean has three types of consonants: plain, aspirated, and tense. This triple contrast is illustrated in the following examples.

- (1)
- a. /pul/ 'fire' /tək/ 'virtue' /ki/ 'spirit' /sal/ 'flesh' /cam/ 'sleep'
- b. /phul/ 'grass' /thək/ 'chin' /khi/ 'stature' _____ /gham/ 'true'
- c. /ppul/ 'horn' /ttək/ 'rice cake' /kki/ 'talent' /ssal/ 'rice' /ccam/ 'leisure'

Unlike the other consonants which show a triple contrast, there is a gap in the /s/-series, where no aspirated form occurs.

In this paper, I claim that Korean tense consonants are geminates based upon phonetic as well as phonological evidence. To support this contention, this paper will be organized as follows: In section II, I will deal with the phonetic realization of tense consonants, comparing it with the phonetic realization of plain consonants. In section III, I will deal with the representation of Korean tense consonants as single segments. In section IV, I will deal with the representation of Korean tense consonants as geminates and show that they are more appropriately represented as geminates than as single segments. In section V, I will summarize the phonetic realization and phonological representation of Korean tense consonants and state my conclusion.

II. Phonetic Realization of Tense Consonants

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Tense consonants are acoustically characterized by a higher fundamental frequency at the beginning of the following vowel than their non-tense counterparts, according to Kim (1965:349), Han and Weitzman (1970:116), Hardcastle (1973:267) and Kagaya (1974:168-9). This acoustic characteristic is due to "isometric muscular tension" in the thyroarytenoideus muscle, that is, the tensing of the muscle without an associated shortening, as stated in Hardcastle (1973:267) and Dart (1987:139). In addition, both Kim (1965: 351) and Dart (1987:146) report that tense consonants have a higher oral pressure than their plain counterparts. This characteristic is due to a marked increase in lateral cricoarytenoid and vocalis muscle activity, presumably resulting in tension of the vocal folds and constriction of the glottis, according to Hirose et al. (1974:151).

Consider now the phonetic realizations of tense and plain consonants. The tense consonants of Korean are fully realized in the onset position in that they show the characteristics described above and keep their contrast with plain and aspirated counterparts, regardless of whether they occur in a word-initial or an intervocalic position, as in (2).

(2) word-initial position	intervocalic position
a. /ppalli/ [p'alli] 'quickly'	/ippal/ [ip'al] 'tooth'
b. /tallo/ [t'alo] 'separately'	/itta/ [it'a] 'afterwards'
c. /kkaci/ [k'adzi] 'until'	/akka/ [ak'a] 'some time ago'
d. /ssacən/ [s'adʒən] 'rice store'	/issusike/ [is'usige] 'toothpick'
e. /ccacan/ [c'adʒan] 'truly'	/kacca/ [kac'a] 'counterfeit'

Tense consonants, if they occur in the coda position without being followed by vowels, become plain consonants as in (3).

- (3) a. /kkəkkt'a/ [k'ək't'a] 'to pick (a flower)
 b. /məkəssta/ [mөгətt'a]¹ 'ate'

There is no contrast between /kk/ and /k/ in the coda position, and /ss/ is not distinguished from /t/.

On the other hand, plain consonants of Korean are fully realized in the onset position so long as they occur in a word-initial position. The contrasts among some of the Korean plain consonants in the coda position, if they are not followed by vowels, are neutralized as in (4).

(4) a. /na_s/ [na_t] 'sickle' b. /na_t/ [na_t] 'grain' c. /na_c/ [na_t] 'day'

cf.) a. /na_s/ + /il/ 'Accusative Case Marker' > /na_sil/ [na_sil]

b. /na_t/ + /al/ 'grain' > /na_tal/ [na_dal] 'grain'

c. /na_c/ + /e/ 'Locative Case Marker' > na_ce [na_dʒe]

There is no contrast among /s/ in /na_s/, /t/ in /na_t/, and /c/ in /na_c/.

In addition, there are two more differences between the phonetic realizations of plain and tense consonants. First, the intervocalic plain consonants become voiced as in (5), while the intervocalic tense consonants do not become voiced as in the second examples of each pair in (2).

(5)	word-initial position	intervocalic position
	a. /palin/ [pa _l in] 'right'	/ipal/ [i _β al] 'haircut'
	b. /ʃacim/ [ʃa _d ʒim] 'pledge'	/iʃa/ [i _β a] 'to be'
	c. /kapu/ [ka _β u] 'right or wrong'	/pu _k a/ [pu _g a] 'addition'

Another difference is that plain and tense consonants differ in length, that is, the duration of closure. Han (1992:216) presents the following table which shows the difference of closure duration between plain and tense consonants.²

(6) Closure Duration of Bilabial and Alveolar Stops in Korean (ms):

phonation	intervocalic		word-initial	
	plain	tense	plain	tense
speaker A	57(12)	172(12)	55(12)	84(12)
speaker B	51(12)	118(12)	51(10)	81(12)
average	54(24)	145(24)	53(22)	83(24)

(): number of tokens

Even though the length of tense consonants varies according to position, they are at least one-and-a-half times as long as plain consonants. These aspects of the phonetic realization of tense consonants imply something about their phonological representation, which will be commented on in the following sections.

III. Tense Consonants as Single Segments

Tense consonants are regarded as single segments by Kim-Renaud (1974), Chung (1980), and Ahn (1985). There are three major pieces of evidence used to support the argument that Korean tense consonants are single segments which are associated with one C-slot in a CV-tier. The three pieces of evidence are concerned with the syllable structure of Korean, resyllabification, and tensification.

1. Syllable Structure of Korean It has been argued that Korean has a (C)V(C) syllable structure at the surface representation. For example, no consonant cluster is allowed in the onset position, while some consonant clusters exist underlyingly in the coda position, as in (7); but even in this case, those clusters are not phonetically realized.

- (7) a. */#lk/ b. */#ks/ c. */#lm/
 /hilk/ 'soil' /nəks/ 'soul' /salm/ 'life'

The consonant clusters in the coda position become corresponding plain consonants and conform to the CVC syllable structure as in (8).

- (8) a. /hilk/ 'soil' [hik] b. /nəks/ 'soul' [nək] c. /salm/ 'life' [sam]

In (8), the contrast among /lk/, /ks/, and /k/ disappears and there is no distinction between /lm/ and /m/.

As already examined, Korean tense consonants occur in both the onset and the coda. If a syllable with a tense consonant in its onset or in its coda is to conform to (C)V(C) syllable structure, tense consonants should be analyzed as single segments.

2. Resyllabification The view of tense consonants as single segments has some advantage in explaining a phonological phenomenon which is called resyllabification, as in (9).

- (9) a. /pap/ 'boiled rice' + /a/ 'Vocative Marker' > $\overset{\sigma}{\uparrow} \overset{\sigma}{\uparrow} \text{p a p a}$
- b. /kim/ 'seaweed' + /il/ 'Accusative Case Marker' > $\overset{\sigma}{\uparrow} \overset{\sigma}{\uparrow} \text{k i m i l}$
- c. /mul/ 'water' + /i/ 'Nominative Case Marker' > $\overset{\sigma}{\uparrow} \overset{\sigma}{\uparrow} \text{m u l i}$

As the above examples show, a segment in the coda position moves to the onset of an adjacent syllable when the segment is followed by a vowel. Since syllabification operates under the maximal onset principle described in Goldsmith (1990:137), a consonant is preferred to be analyzed as occupying a syllable onset rather than a syllable coda. The following examples make it clear that only one of the segments in the coda position undergoes resyllabification, if two segments occupy the coda position.

- (10) a. /salm/ 'life' + /il/ 'Accusative Case Marker' > $\begin{matrix} \sigma & \sigma \\ \wedge & \wedge \\ s a l m & i l \end{matrix}$
- b. /hilk/ 'soil' + /i/ 'Nominative Case Marker' > $\begin{matrix} \sigma & \sigma \\ \wedge & \wedge \\ h i l k & i \end{matrix}$
- c. /nəlp/ 'wide' + /i/ 'Nominalizing Marker' > $\begin{matrix} \sigma & \sigma \\ \wedge & \wedge \\ n ə l p & i \end{matrix}$

Consonant clusters /lm/, /lk/ and /lp/ as a whole cannot move to the onset of the adjacent syllable because the onset clusters are not allowed.

The following examples contain tense consonants in the coda position.

- (11) a. /kkək/ '- to pick' + /i/ 'Nominalizing Marker' > $\begin{matrix} \sigma & \sigma \\ \wedge & \wedge \\ k k ə & k k i \end{matrix}$
- b. /sa-/ 'to buy' + /ss/ 'Past Tense Marker' + /il/ 'Adjectival Marker' > $\begin{matrix} \sigma & \sigma \\ \wedge & \wedge \\ s a & s s i l \end{matrix}$

Tense consonants in the coda of the first syllable are resyllabified as being in the onset of the next syllable. If the target of resyllabification is only one segment in the coda, the resyllabification phenomenon of tense consonants as in (11) supports the claim that tense consonants /kk/ and /ss/ are single segments.

3. **Tensification** Tensification is a phonological phenomenon in Korean whereby a target consonant is realized as a tense consonant. If tensification is regarded as the change of a phonetic feature of a target plain consonant, this view of tensification presupposes that tense consonants are single segments. Ahn (1985:56-73) classifies several types of tensification in Korean, according to the internal structure of

the word which undergoes the above mentioned phonological process. The first is the tensification of a consonant following an obstruent, which usually occurs in "Noun+Noun" compounds as in /^heksaŋ/ [tʃeks'aŋ] 'study table'. The second type of tensification occurs in "Predicate stem + Ending" as in /sin-ta/ [sin'ta] 'to wear (shoes) + Declarative Marker'. The third is the tensification of a consonant following a lateral sound, which occurs in "Determiner (from verb/ adjective) + Noun" compounds as in /tʌlkam/ [t'ɛlk'am] 'fire wood'. The fourth type of tensification occurs in Sino-Korean³ words as in /paltal/ [palt'al] 'development'. Ahn formulates the following rules to explain the various types of tensification.

- (12) a. Post-Obstruent Tensing (POT)
 [-son] → [+tense] / [-son] _____
 b. Predicate Tensification
 [-son] → [+tense] / [+nasal]] V/A _____ (domain: Stratum 4⁴)
 c. Determiner Tensification
 [-son] → [+tense] / [+lateral]] D _____ (domain: post-lexical)
 d. Sino-Korean Tensification
 [-son] → [+tense] / [+lateral] _____
 [+cor]

This formulation may be a good description of the phenomena discussed thus far, but is not sufficient to deal with the following phenomenon which is, without a doubt, in the category of tensification. In a word, Ahn's (1985) approach cannot generalize the tensification of Korean.

- (13) a. /sonʃin/ 'back of the hand' [sonʃ'in]
 /son/ 'hand' + /ʃin/ 'back'
 b. /mulka/ 'waterside' [mulk'a]
 /mul/ 'water' + /ka/ 'side'
 c. /tinpul/ 'lamplight' [tinp'ul]
 /tin/ 'lamp' + /pul/ 'light'

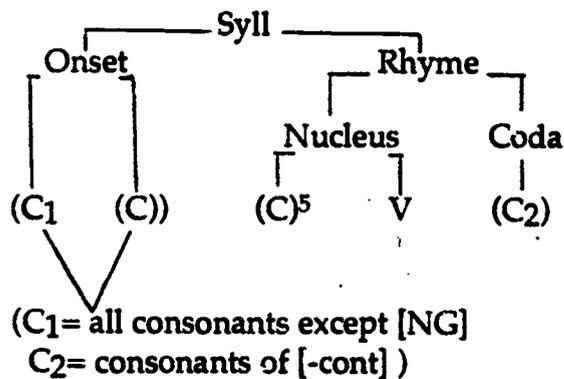
To explain this type of tensification, another rule will be required. In summary, the categorization of Korean tense consonants as single segments explains syllable structure and resyllabification in Korean, but does not generalize tensification.

IV. Tense Consonants as Geminates

Tense consonants are considered geminates by Whitman (1985), Kim (1986), Sohn (1987), Han (1992), and Kim (1992). There is much evidence to support the argument that Korean tense consonants are geminates which occupy two C-slots in a CV-tier. Even some of the supporting evidence for the argument that tense consonants are single segments (for example, syllable structure of Korean and tensification) can be reinterpreted as evidence in support of the view that Korean tense consonants are geminates.

1. Syllable Structure of Korean An alternative to viewing Korean syllable structure as (C)V(C) is based upon the assumption that tense consonants are geminates. Kim (1986:109) presents the syllable template of Korean as in (14).

(14) Syllable Template of Korean



As diagram(14) shows, geminates are the only case where an onset may branch and thus onset clusters are not allowed. The reason consonant cluster onsets are not permissible may be related to the fact that each of the Cs of a consonant cluster is linked to a different element on the harmony tier as in (15a), whereas each of the Cs of a geminate is linked to a single element as in (15b).



In addition, Whitman (1985:285) argues that the existence of geminates in the onset position will require us to allow for branching onsets. The resultant generalization is that Korean allows syllables of the form CCV(C), but not *(C)VCC. This alternative view of Korean syllable structure explains the difference in the distribution of consonant

clusters and tense consonants as well as the former view of Korean syllable structure as (C)V(C) does.

2. **Length of Tense Consonants** The phonological representation, whereby tense consonants are regarded as geminates, explains in a straightforward way why tense consonants are longer than plain consonants. It is natural that geminates, which occupy two C-slots, should be longer than plain consonants, which occupy only one C-slot, since each C-slot indicates a timing unit.

3. **Tensification** Tensification is explained by Whitman (1985), Kim (1986), Sohn (1987), and Kim (1992) in terms of the insertion of a timing slot and the spreading of features. Kim (1992:94-95) explains tensification in terms of the rule of implosion (that is, a non-explosion whose function is the insertion of a timing slot) and in terms of the rule of spreading as follows:

(16) a. The Rule of Implosion

$$\phi \rightarrow x / x \quad \underline{\quad} \quad x$$

[+obst] [+obst]

b. The Rule of Spreading

$$\begin{array}{c} x \quad x \\ | \quad | \\ \alpha \quad \alpha \end{array} \rightarrow \begin{array}{c} x \quad x \\ \diagdown \quad | \\ \alpha \quad \alpha \end{array}$$

Ahn's (1985) approach was described as requiring a new rule to deal with the examples in (13). However, instead of the formulation of a new rule, we can simply apply the view of tensification as the insertion of a timing slot and spreading to explain those examples. In other words, this view can generalize various types of tensification of Korean in a simple and elegant manner.

This analysis of tensification can be associated with a representation of tense consonants. If tense consonants are assumed to be geminates which occupy two C-slots, tensification can be explained as a straightforward process of gemination. However, if tense consonants are assumed to be single segments, further manipulation is required to reduce two C-slots, which are acquired as a result of tensification, into one C-slot. Furthermore, Korean tense consonants have properties of geminates which are described in Goldsmith (1990:76-82).

4. **Accent Patterns of Korean** Goldsmith (1990:76-82) makes four generalizations concerning geminate consonants, the first of which is that rules that are sensitive to syllable weight, or that establish syllable weight, treat geminate consonants as if they were two consonants. For example, in a language with severe restrictions on syllable codas and onsets, in which a CVC syllable counts as a heavy syllable, the first syllable of a sequence like [bigga] is treated as a heavy syllable because the first part of the geminate **gg** is syllabified as the coda of the first syllable.

A rule which is sensitive to syllable weight is found in Korean. A different accent pattern exists between a word like /ikki/ which is composed of a vowel followed by a tense consonant and a vowel, and a word like /aki/ which is composed of a vowel followed by a plain consonant and a vowel. The word /fkki/ 'moss' has its primary accent on the first syllable, whereas the word /akí/ 'baby' has its primary accent on the second syllable as in Han (1992:210). To explain accent patterns in Korean, Yu (1988:322) proposes the following accent rules:

(17) The Accent Rules of Standard Korean

- a. Give the primary accent on the leftmost heavy syllable of a 'mot phonétique'.
- b. If there is no heavy syllable in the 'mot phonétique', give the primary accent to the rightmost light syllable.

The accent placement on the first syllable of /fkki/ is a result of the application of rule (17a), which means that the first syllable is considered a VC sequence, in other words, the first syllable is regarded as heavy. If the first syllable is to be heavy, the tense consonant should be analyzed as occupying two C-slots in a CV-tier. The first C is in the coda of the first syllable, while the second C is in the onset of the next syllable.

5. **Distribution of Tense Consonants** The second generalization of Goldsmith (1990:77) is that geminate consonants frequently are allowed in positions where sequences of different consonants are not allowed. Korean has 11 underlying consonant clusters.⁶ They occur in syllable-final position but cannot occur in syllable-initial position. But Korean tense consonants are allowed in the syllable-initial position as in (18) and some of the tense consonants occur in the syllable-final position too, as in (18c-d).

- (18) a. /ppun/ 'only' b. /ttam/ 'sweat' c. /kkəm/ 'gum'
 */pp#/ */tt#/ /səkkta/ 'to mix'
 d. /ssə/ 'bitter' e. /ccim/ 'steamed food'
 /əss/ 'Past tense Marker' */cc#/

This pattern of distribution of the Korean tense consonants matches Goldsmith's (1990) second generalization of geminates.

6. Integrity The third generalization of geminates is concerned with the integrity of geminate consonants. Rules of epenthesis, whereby a vowel is inserted to break up impermissible sequences, fail to apply if their application would separate the halves of a geminate. Such a rule of epenthesis is found in Korean. An epenthetic /i/ is inserted to avoid the impermissible sequences of consonants as in (19).

- (19) /mæk-/ 'to eat' + /lə/ 'Ending for purpose' > /mæk+i+lə/ >
 [məkilə]

To avoid the sequence of /k/ and /l/, /i/ is inserted. The rule of epenthesis in Korean, however, cannot apply to tense consonants. For example, the tense consonant /kk/ of /takki/ 'a person who shines (something)' can never be separated by an epenthetic /i/. The insertion of the epenthetic /i/ into /takki/ results in the unacceptable */takiki/. This fact that the epenthetic rule of Korean does not apply to Korean tense consonants is consistent with Goldsmith's (1990) third generalization of geminates.

7. Inalterability The last generalization of geminates in Goldsmith (1990:80) is that rules that modify the segmental quality of consonants fail to apply to geminates. Korean has a voicing rule which changes voiceless consonants into voiced ones intervocalically as in (20).

- (20) a. /aka/ [aga] 'baby' b. /opa/ [oba] 'overcoat'
 c. /suʈa/ [suda] 'chattering'

Plain consonants are affected by this voicing rule as in (20), whereas tense consonants are not affected by this rule as in (21).

- (21) a. /akka/ [ak'a] 'sometime ago' b. /oppa/ [op'a] 'brother'
 c. /itta/ [it'a] 'afterwards'

If this voicing rule is defined to be a spreading rule, whereby the voicing feature is spread to only one skeletal slot, the reason tense consonants do not undergo this spreading rule can be explained by the assumption that tense consonants are geminates which occupy two skeletal slots. As stated, the four generalizations about geminates in Goldsmith (1990) support the argument that Korean tense consonants are geminates.

V. Conclusion

From the evidence presented, it can be concluded that the tense consonants of Korean are geminates. Phonetic realizations and phonological phenomena concerning Korean tense consonants support this conclusion. Tense consonants in Korean are acoustically and articulatorily differentiated from plain consonants. Tense consonants, unless they are in the coda without a following vowel, are phonetically fully realized in that they show their own phonetic characteristics, such as a higher fundamental frequency at the beginning of the following vowel, and a higher oral pressure. The crucial phonetic realizations of Korean tense consonants, concerned with the phonological representation of them, is that first, tense consonants are not realized as voiced ones as corresponding plain consonants do and secondly, the closure duration of tense consonants is longer than that of plain consonants. These aspects of the phonetic realization of tense consonants are reasonably explained if tense consonants are geminates which occupy two C-slots in a CV-tier. Furthermore, there are some phonological phenomena which can be explained if tense consonants in Korean are regarded as geminates and, in fact, these phenomena match the characteristics of geminates described in Goldsmith (1990). These characteristics include the distribution of Korean tense consonants, their integrity and inalterability, and their influence on the syllable weight, which plays an important role in determining accent placement.

While there is some evidence to support the view that Korean tense consonants are single segments, most of it can be reinterpreted as evidence for the argument that Korean tense consonants are geminates.

The only problem with the representation of Korean tense consonants as geminates is that this view cannot provide a satisfactory explanation of resyllabification. One may try to reinterpret even resyllabification to make it a piece of supporting evidence for Korean

tense consonants as geminates. But this trial induces a rather complex process, the reality of which is dubious. Consider the first example of (11) again, as in (22).

- (22) a. /kkək-/'to pick' +/i/ 'Nominalizing Marker'> b. /kkək ki/>
 c. /kkə kki/

(22b) is a result of resyllabification whereby only the second C-slot in the coda position moves to the onset of the adjacent syllable. In order to get (22c), tensification and "CC cluster Simplification" should apply to (22b).

NOTES

¹ This is not a final phonetic form. The final form is [məŋət'a]. In order to get this form, [məŋət'a] should undergo what Ahn (1985:65) calls "CC cluster Simplification," whereby [tʰ] is changed into [t]. In each of the examples, intervocalic voiceless consonants are represented as voiced counterparts in their phonetic forms. In this example, intervocalic /k/ is realized as [g].

² Dart (1987) also points out the difference of closure duration between tense stops and plain stops. According to Dart (1987:42), the average closure duration of all plain stops is 133.5 ms, and that of all tense stops is 188.25ms.

³ Sino-Korean stands for Chinese loan words. It can be said that Sino-Korean is to Korean what Latinate-English is to English. Pure Korean words do not undergo tensification in the same environment as Sino-Korean words. Compare the following two examples.

- (1) /alci/ [aldzi] '(you) know?' (pure Korean)
 (2) /ilci/ [ilʰci] 'diary' (Sino-Korean)

The underlined phoneme, whose features are [-son], [+cor] etc., is tensified in the environment [+lateral] _____, only in the Sino-Korean words.

⁴ Ahn (1985:36) assumes that the stratified allocation of word formation processes in the lexicon of Korean is as follows: sub-compounding in stratum 1, co-compounding in stratum 2, derivation in stratum 3, and inflection and Case marking in stratum 4. Sub-compounding is defined as a word-formation process which has a "modifier + head" distinction, while co-compounding is a construction in which there is no "modifier + head" distinction.

⁵ The C-slot in the Nucleus indicates the position where Korean glides [y] and [w] occur. For example, the syllable structure of /kʷo/ 'religion' is analyzed as [[k] _o [[yo] _N] _R] _s.

⁶ Ahn (1985:167) presents the following consonant clusters as possible codas: ps, ks; nc; lp, lp^h, lt^h, lk; ls, lh; lm; nh. Kim (1986:123-25) includes tensed geminates such as kk, tt, etc. and aspirated geminates such as ph, th, kh in the category of consonant clusters. I follow Ahn's (1985) approach to possible codas.

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