The underlying representation of tense consonants in Korean revisited: A government approach

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Rhee, Sang Jik. 2012. **The underlying representation of tense consonants in Korean revisited: A government approach.** *Studies in Phonetics, Phonology and Morphology* 18.1, 111-129. The issue of the underlying representation of tense consonants in Korean is highly controversial. Two competing proposals have been put forward, i.e. the singleton and the geminate hypothesis. The former regards a tense consonant as a singleton underlyingly, while in the latter a tense consonant is lexically specified as a geminate lax obstruents. This paper argues against the geminate hypothesis on the basis of the phonotactic constraints on coda-onset clusters in Korean, including geminates. We investigate whether or not a geminate lax obstruent is phonotactically well-formed in Korean. On the basis of the assumption that a geminate is syllabified as a doubly-linked coda-onset cluster, this paper explores the distribution of [ɨ] in Korean, since this vowel plays a crucial role in determining the well-formedness of internal coda-onset clusters. The absence of this vowel between certain consonants indicates that the sequences of liquid-nasal and liquid-lax obstruent are well-formed coda-onset clusters. When the order of sequences is reversed, however, the vowel [ɨ] is present. The geminate hypothesis incorrectly predicts that the vowel [ɨ] is absent in (identical) two lax obstruent sequences. The examples, such as [tɨtiə] 'at last', show that this vowel does occur between two lax obstruents. This suggests that these clusters are not well-formed. Therefore, the presence of [ɨ] in this position significantly undermines the geminate hypothesis. We conclude that a tense consonant is underlyingly represented as a singleton. **(Chungnam National University)**

Keywords: the underlying representation of tense consonants, phonotactic constraints on consonant clusters, the singleton and the geminate hypothesis, presence or absence of [ɨ]

1. Introduction

Traditionally, obstruents in Korean are classified as having one of three phonation types, viz. lax (C), tense (C') and aspirated (C^h). The contrast among these consonants is illustrated by the minimal pair: *pul* 'fire', *p'ul* 'horn' and *p ʰul* 'grass'. While most analyses assume that this three-way contrast is present in underlying representations (Kim-Renaud 1974, Ahn 1985, Sohn 1987, among others), there have been a number of attempts to reduce the ternary contrast in a binary one. This approach, sometimes dubbed the geminate hypothesis, argues that a tense consonant is underlyingly represented by a geminate lax obstruent (Martin 1951, J.-M. Kim 1986, Yu 1989, S.-H. Kim 1990, Han 1992, 1996, Jun 1994, Avery and Idsardi 2001, Ahn and Iverson 2004, among others). In this way, the contrast is reduced to a two-way one: lax vs. aspirated. An intermediate version of this approach was put forward by Tak and Davis (1994), who

proposed that a tense consonant is treated as a singleton in a non-derived context but represented by a geminate in a derived environment.

A number of analyses have explicitly argued against the geminate hypothesis (Cho and Inkelas 1994, Davis and Lee 1996, Cho and Iverson 1997, Oh and Odden 1997, Oh 2000, H. Kim 2005, among others). For instance, Davis and Lee noted that 'true' geminates and tense consonants behave differently with respect to umlaut in Korean. Normally, umlaut optionally applies to /a/ or /ə/ to become [ɛ] or [e] across a single consonant followed by the vowel /i/, e.g. /mati/ [mati] or [mɛti] 'knot'; /əmi/ [əmi] or [emi] 'mother'. Crucially, this process does not apply across a true geminate, e.g. /ənni/ [ənni] *[enni] 'elder sister'; /alli/ [alli] *[ɛlli] 'to inform'. If a tense consonant is lexically represented as a geminate, it is predicted that umlaut is blocked. However, the data clearly show that this is not the case, e.g. /ak'i/ [ak'i] or [ɛk'i] 'to spare'; /tʰok'i/ [tʰok'i] or [tʰök'i] 'rabbit', etc. These facts provide *prima facie* evidence against the geminate hypothesis.

In this paper, we will put forward another piece of evidence against the geminate hypothesis, related to phonotactics. We will investigate a number of sequences of lax obstruents and see whether these are well-formed or not in Korean, as evidenced by the occurrence of [ɨ], which is used to break up illicit coda-onset clusters (Heo 1995, Rhee 2002). Acceptable sequences, such as a liquid-nasal clusters (e.g. [kolmok] 'alleyway') or a nasal-lax stop clusters (e.g. [pəngɛ] 'lightning'), are not broken up by the vowel [ɨ]. When the order of consonants is reversed, however, this vowel invariably breaks up the cluster, e.g. a nasal-liquid sequence (e.g. [kɨrəmɨro] 'therefore') or a lax stop-nasal sequence (e.g. [nakɨne] 'traveler'). Since geminates are conventionally syllabified as doubly linked coda-onset clusters, the geminate hypothesis would predict that the vowel [ɨ] does not occur between two identical lax consonants (Schein and Steriade 1986, Hayes 1986). This prediction, however, is not borne out, as we will see. The inevitable conclusion is that Korean does not have true geminate lax obstruents, which thus provides vital evidence against the geminate hypothesis.
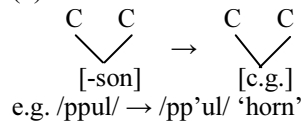
This paper is organised as follows. In section 2, we examine the main points of the geminate hypothesis in detail, in particular on the basis of the influential proposals by Han (1992) and Ahn and Iverson (2004). We point out that evidence presented in their proposals is not crucially in favour of the geminate hypothesis. In section 3, we describe the distribution of the vowel [ɨ] in monomorphemic words. We show that the well-formedness of consonant clusters is signalled by the presence or absence of an intervening [ɨ]. In section 4, we present the evidence against the geminate hypothesis. We argue that the presence of [ɨ] between two lax obstruents in internal position and the occurrence of the preceding [ɨ] before coda-onset clusters in initial position significantly undermine the geminate hypothesis. The final section summarises the main points of this paper.

2. A review of the geminate hypothesis

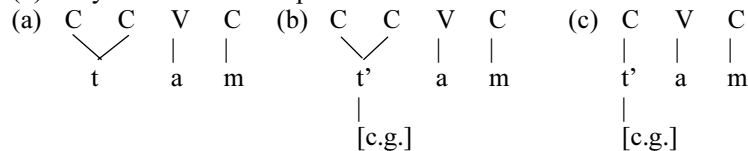### 2.1 The proposals of Han (1992) and Ahn and Iverson (2004)

Han (1992) claimed that the contrast between lax and tense consonants is characterised by the number of timing units: lax consonants occupy a single unit, while tense ones occupy two. Thus, tense consonants are underlyingly lax geminate consonants. To derive a surface tense consonant, Han proposes a rule of Geminate Reinforcement (henceforth GR) which inserts the feature [constricted glottis] (henceforth [c.g.]) on the geminate, as shown below.

(1) Geminate Reinforcement

$$\begin{matrix} \text{C} \quad \text{C} & & \text{C} \quad \text{C} \\ \diagdown\diagup & \rightarrow & \diagdown\diagup \\ \text{[-son]} & & \text{[c.g.]} \end{matrix}$$
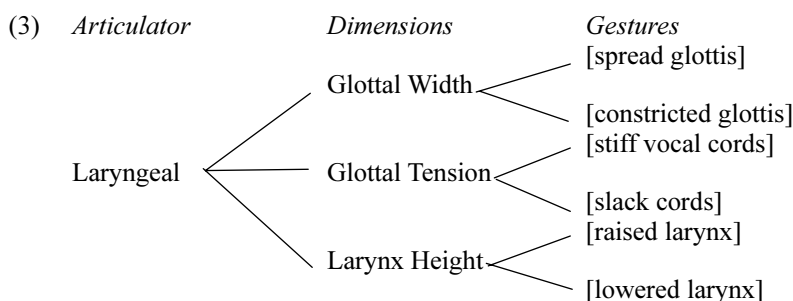
e.g. /ppul/ → /pp'ul/ 'horn'

After the application of GR, the surface geminate consonant violates the constraint of syllable structure of Korean which does not allow consonant clusters either in onset or coda position. For instance, when a word ends in a consonant cluster such as in /hɨlk/ 'earth', one of the two consonant must be deleted and so the phonetic form [hɨk] emerges. When a vowel-initial suffix such as the nominative suffix /i/ follows, the two consonants are phonetically realised, as in [hɨlki] 'earth-NOM'. The same observation can be made regarding complex onset clusters in English loanwords such as in *train*: the vowel [ɨ] is inserted between the consonant cluster, as in [tʰɨrein] to preserve the maximal content from the source language (cf. Rhee 2002). Accordingly, a word with an initial tense consonant on the surface is in conflict with the syllable well-formedness condition. To solve this, Han (1992) suggests that one C-slot of the geminate is deleted by the application of Stray Erasure (Steriade 1982). For instance, consider the phonetic form [t'am] 'sweat'. As shown below, (2a) is the underlying representation /ttam/. The GR applies to the initial geminate to become the tense consonant, as in (2b). In (2c), the ill-formed initial geminate is resolved by the application of Stray Erasure where one slot of the geminate is deleted.

(2) Stray Erasure in initial position

$$\begin{matrix} \text{(a)} & \text{C} \quad \text{C} \quad \text{V} \quad \text{C} & \text{(b)} & \text{C} \quad \text{C} \quad \text{V} \quad \text{C} & \text{(c)} & \text{C} \quad \text{V} \quad \text{C} \\ & \diagdown\diagup \quad | \quad | & & \diagdown\diagup \quad | \quad | & & | \quad | \quad | \\ & \text{t} \quad\quad \text{a} \quad \text{m} & & \text{t'} \quad\quad \text{a} \quad \text{m} & & \text{t'} \quad \text{a} \quad \text{m} \\ & & & | & & | \\ & & & \text{[c.g.]} & & \text{[c.g.]} \end{matrix}$$

In this analysis, the Geminate Reinforcement rule and Stray Erasure are the two main formal tools to derive surface tense consonants. This is the main point of Han (1992).
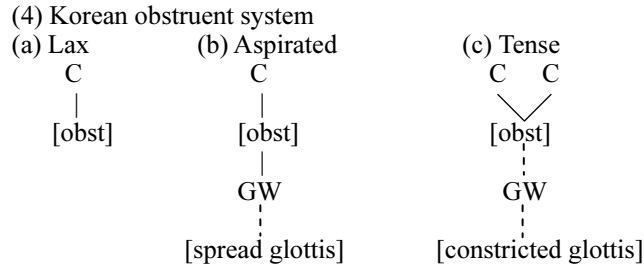
Next, consider another proposal along the lines of the geminate hypothesis. Following the theory of Laryngeal Dimensions by Avery and Idsardi (2001), Ahn and Iverson (2004), like Han (1992), propose that tense consonants are not underlyingly represented by singletons but by geminate lax consonants. In this theory, the laryngeal information is organised into three levels: Articulator, Dimensions, and Gestures, as shown below.

(3)   *Articulator*   *Dimensions*   *Gestures*
                                                          [spread glottis]
                            Glottal Width
                                                          [constricted glottis]
                                                          [stiff vocal cords]
       Laryngeal   Glottal Tension
                                                          [slack cords]
                                                          [raised larynx]
                            Larynx Height
                                                          [lowered larynx]

The articulator level corresponds to the laryngeal node in the standard approach to Feature Geometry (Clements 1985, McCarthy 1988). Under the articulator level, there are three laryngeal dimensions: Glottal Width (GW), Glottal Tension (GT) and Larynx Height (LH). Each dimension contains a muscle group forming antagonistic gestures, viz. [spread glottis] vs. [constricted glottis]; [stiff vocal cords] vs. [slack vocal cords] and so on. Laryngeal contrasts are encoded at this level, in that only one member of an antagonistic pair can be active in a given language: e.g. a language employs either [spread glottis] or [constricted glottis], but not both. Note that the contrast is manifested at the level of the dimensional node. The terminal elements themselves, i.e. gestures, are absent in the phonological representation. Rather, they are implemented progressively as the representations become more phonetic. For instance, the laryngeal contrasts in English and Japanese are carried out at the level of the GW and the GT dimension, respectively. In English, unmarked lenis obstruents contrast with fortis obstruents containing [spread glottis] and voiced obstruents with [slack glottis] contrast with laryngeally empty voiceless obstruents in Japanese. These two gestures are added by a default operation at a later stage.

Regarding the three-way distinction among obstruents in Korean, Avery and Idsardi (2004) propose that the three-way contrast is completed at the level of the GW dimension, i.e. lax obstruents are laryngeally unmarked and aspirated obstruents are marked with the GW dimension. The

remaining tense obstruents are represented by a geminate of lax obstruent, as illustrated in (4).

(4) Korean obstruent system
(a) Lax   (b) Aspirated   (c) Tense

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      C                     C                        C   C
      |                     |                         \ /
   [obst]                [obst]                     [obst]
                            |                          ⋮
                           GW                         GW
                            ⋮                          ⋮
                    [spread glottis]        [constricted glottis]
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In English, the aspirated obstruents in Korean are represented by the GW dimension so that the default gesture [spread glottis] is implemented in the surface realisation as indicated by the dotted lines. The phonetic realisation of tense consonants is achieved by *Korean enhancement*, whereby geminate obstruents acquire the GW dimension along with the gesture [constricted glottis] (Ahn and Iverson 2004). So far, this proposal runs more or less parallel with that of Han (1992) above.

With respect to the occurrence of geminate lax obstruents in initial position, Ahn and Iverson propose a different treatment from Han (1992). They propose that these geminates are immune to the consonant cluster constraint in which initial consonant clusters are prohibited.

(5) (a) * C   C   (b)   C   C

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            |    |                  \ /
           [ ]  [ ]                 [ ]
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(5a) indicates that a sequence of singletons violates the consonant cluster constraint. A geminate as in (5b), however, is permissible due to the effect of the Linking Constraint (Hayes 1986), which states that association lines in structural description are interpreted as exhaustive. Since the doubly-linked association lines in geminates do not exactly match the singly-linked ones in (5a), the tense consonants represented by a geminate are acceptable in onsets in the same way as are singleton consonants.

Next, we introduce several arguments against the geminate hypothesis on the basis of Han (1992) and Ahn and Iverson (2004).

2.2 Discussion on the geminate hypothesis

With respect to the geminate hypothesis based on articulatory and acoustic evidence, consider post-obstruent tensification in Korean. When a sequence of two lax obstruents is generated by morpheme concatenation, this process applies to the second obstruent, which becomes tense by the

insertion of the feature [tense] or [constricted glottis] (Kim-Renaud 1975, Sohn 1987), e.g. /cuk[1] + ko/ [cukk'o] 'to die, and'; /tat + ta/ [tatt'a] 'to close, declarative suffix'. Kim-Renaud noted that tensification occurs when a lax obstruent is preceded by an *unreleased* stop.[2] Thus, the closure phase of the preceding stop is extended into the following obstruent, and the longer duration will build up a greater oral air pressure. The increase of air pressure yields the effect of longer glottal closure and this, in turn, produces the phonological equivalent of the constriction of the glottis or tensity. This articulatory account implies that tense consonants require longer closure duration, so that underlying tense consonants might well also be represented as geminates.

This implication is acoustically supported. In general, the closure duration in intervocalic position is shortest for lax stops, intermediate for aspirated stops, and longest for tense stops (Silva 1992, Han 1996). These results were confirmed by Rhee (2007) who found that the mean durations of each type are 61ms, 128ms and 150ms, respectively. The closure duration of tense consonants is more than twice as longer than their counterparts. Han interpreted the longer duration involved in tense consonants as phonological length so that a lax and a tense consonant occupies one C-slot and two C-slots in the underlying representation, respectively (see above).

However, if the longer duration of tense consonants is an argument for the geminate analysis, then the aspirated consonants also deserve to occupy two slots underlyingly, since the closure duration in aspirated obstruents is also twice as longer than that of their lax counterparts.[3] Neither Han nor Ahn and Iverson address this problem at all. In particular, within the Laryngeal Dimension theory, there is no way to represent an aspirated obstruent as a geminate, since the GW dimension represents aspirated consonants as singletons underlyingly. Unless this problem can be solved, we must dismiss the evidence from closure duration as non-crucial.

The second argument is concerned with the phonetic difference between /ak+ki/ 'instrument' and /ak'i/ 'to spare'. In the literature, these forms are conventionally transcribed as [akk'i] and [ak'i], respectively. Note that the first form is the result of post-obstruent tensification applied to a sequence

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[1] Instead of /ʧ, ʧ', ʧʰ/ in the IPA chart, the symbols /c, c', cʰ/ are used to refer to palato-alveolar affricates for notational convenience.

[2] This process is known as neutralisation whereby all obstruents become unreleased in coda position.

[3] Though this paper will not discuss the underlying representation of aspirated consonants in detail, this topic has received different treatments. Like Avery and Idsardi, Han (1996) argues that aspirated consonants are represented by a singleton consonant. On the other hand, Yu (1989), S.-H. Kim (1990), and Jun (1994), among others, claim that aspirated consonants are also represented by a sequence of consonants. Yu proposes that an aspirated consonant consists of a lax consonant with /h/ and S.-H. Kim asserts that it is denoted by a lax consonant with the feature [spread glottis] underlyingly. Neither of these viewpoints explains the phonetic length difference, so we will leave this topic for future research.

of lax obstruents. Han (1992) claims, however, that these two forms are phonetically indistinguishable. This implies that /k+k/ and /k'/ can be treated underlyingly in the same way; in particular, the latter form can be treated as an underlying geminate. However, Tak and Davis (1994) and Cho and Iverson (1997) observe that these two forms can be realised differently in careful speech. In this style, they argue that an articulatory pause can occur between the first and the second syllable in /ak+ki/ but not in /ak'i/. This shows that the phonetic data is, at best, inconclusive as a sufficient criterion for or against the geminate hypothesis.

Another point regarding the geminate hypothesis cited by Han comes from the stress-accent patterns in standard Korean. Note that the realisation of accent patterns concerns the phonetic level, since stress-accent does not lexically contribute to any contrast in meaning. Bearing this in mind, Yu (1988, 1989) proposes the following rules of accent placement.

(6) Stress-accent placement in standard Korean
    A primary accent falls on the following contexts:
    (a) The leftmost heavy syllable
    (b) The rightmost light syllable if no heavy syllable is present.

For instance, in disyllabic words such as [kúlt'uk] 'chimney' and [saráŋ] 'love', the accent falls on the heavy syllable irrespective of the position. If no heavy syllables are present, the accent falls on the rightmost light syllable, e.g. [imá] 'forehead' and [sorí] 'sound'. Consider now the following words in which the accent placement is different despite the identical syllable structure VCV.

(7)   (a)   [ík'i]   'moss'   [kíp'ɨm]   'happiness'
      (b)   [akí]   'baby'   [kipún]   'mood'

Yu claims that the words with a tense consonant in (7a) receive accent on the first syllable. In contrast, the words with a lax consonant in (7b) have accent on the second syllable. The initial accent in the former would suggest that the tense consonants contribute to the weight of the first syllable. If this accentual intuition is correct, these data would support the geminate hypothesis, since the first syllable can be closed by the first member of a geminate.

However, the accentual pattern uncovered by Yu is questionable empirically. H.-B. Lee (1974) proposes rather different accent rules from Yu in that the accent falls on the first syllable if it is heavy, and otherwise, it falls on the second. These proposals make different predictions for the accentual pattern in tri-syllabic words consisting of light syllables only. For instance, in words such as [satari] 'ladder' and [kɛkuri] 'frog', the accent would fall on the last syllable in Yu's proposal but on the second in Lee's, because the rightmost syllable attracts accent in the former proposal but the

second syllable does so in the latter. The accentual perception between the two further deviates in underived tense consonants.

(8)   Yu   [ák'i]   'to spare'   [tók'i]   'axe'
      Lee   [ak'í]   'to spare'   [tok'í]   'axe'

According to Lee, the accent falls on the second syllable, which implies that a tense consonant is *not* a geminate underlyingly. Thus, accentuation also does not contribute to reliable evidence for the geminate hypothesis.

   In sum, the arguments regarding the geminate account of tense consonants do not hold water on deeper scrutiny. The supporting evidence put forward by Han is not compelling enough to substantiate the geminate hypothesis. In the next section, we will provide phonotactic evidence *against* the geminate hypothesis. To do this, we will first consider the distribution of the vowel [ɨ], which signals the well-formedness of coda-onset clusters. We formally account for the distribution of [ɨ] in terms of inter-onset government which is part of the Empty Category Principle (Kaye 1995, Rhee 2002).

3. The distribution of the vowel [ɨ] in Korean

3.1. A summary of the distribution of [ɨ]

Unlike other lexical vowels in Korean, the vowel [ɨ] is unique in that this vowel is subject to ɨ/zero alternations in suffixation, and to epenthesis in loanwords. Its status as a "default" vowel in Korean is generally agreed upon. What mainstream analyses have not dealt with is the distribution of [ɨ] in monomorphemic words, since, surprisingly, this vowel has been treated on a par with other lexical vowels. However, also in this domain, there is positive evidence that this vowel must be treated differently from other vowels, because the occurrence of [ɨ] is completely predictable morpheme-internally.

   In final position, the vowel [ɨ] normally does not occur.[4] Internally, the occurrence of this vowel is sensitive to the surrounding consonants. Namely, the presence of the vowel [ɨ] depends on whether or not a surrounding consonant cluster can constitute a coda-onset sequence. Consider the following consonant sequences.

(9)   (a) between L+N and L+LO
       [kolømok]   'alley'   [kətɨlømək]   'arrogant'
       [tasɨløki]   'gastropod'   [kaløpi]   'rib'

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4 There are exceptions to this statement, viz. [kɨ] 'he', [jənɨ] 'other' and [ənɨ] 'which'. Also, there are some ideophonic words ending in a vowel [ɨ], e.g. [urɨrɨ] 'all at once'; [cwarɨrɨ] 'with a splash'.

    (b) between L+TAO
      [kal<u>øk</u>ʰi]   'wooden rake'   [sal<u>øp</u>ʰi]   'to consider'
      [mal<u>øt</u>'oŋ]   'blankly'   [tɨl<u>øs</u>'ək]   'to budge'
    (c) between N+LO
      [pə<u>nø</u>gɛ]   'lightening'   [si<u>mø</u>burɨm]   'errand'
      [ə<u>nø</u>dəɲi]   'hip'
    (d) between N+TAO
      [sikɨ<u>mø</u>cʰɨ]   'spinach'   [pə<u>nø</u>c'ək]   'sparkling'
(L: liquid LO: lax obstruent N: nasal TAO: tense or aspirated obstruent ø: absence of [ɨ])

The underlined consonants in (9) can form a coda-onset cluster and the vowel [ɨ] is absent. Note that these clusters require the presence of a following vowel. If there is no following vowel, [ɨ] must occur between the two consonants, e.g. for L+N sequences [kərɨm] 'fertiliser'; L+LO sequences [turɨp] 'aralia shoot'.

   However, when the order of the consonant in the cluster is reversed, the vowel [ɨ] is present between the two consonants in question, irrespective of the presence of a following vowel.

(10)   (a) between N+L or LO+L
        [ci<u>nɨr</u>əmi]   'fin'   [hə<u>tɨr</u>e]   'trash'
        [pu<u>sɨr</u>əm]   'ucler'   [sinapɨro]   'gradually'
    (b) between LO+N
        [nak<u>ɨn</u>e]   'stranger'   [ko<u>cɨn</u>ək]   'silent'
        [sɨløk<u>ɨm</u>əni] 'secretly'

The distribution of [ɨ] in (9) and (10) clearly shows that the occurrence of this vowel is not arbitrary. Rather, it is controlled by the presence or absence of following vowels and the quality of surrounding consonants. There are various ways of capturing the distribution of the vowel [ɨ] formally, e.g. in terms of sonority. In this paper, we will adopt the notion of empty nuclei, and sketch out the framework of Government Phonology in the next section.

   3.2 Empty nuclei in Korean and the Empty Category Principle (ECP)

Empty nuclei are not a novel notion. For instance, Underspecification Theory (UT) treats the Korean vowel [ɨ] as an empty nucleus in phonological representation: it is the maximally underspecified vowel (Sohn 1987). In this framework, the empty nucleus is deleted or inserted in appropriate context. The approach adopted in this paper differs from UT in that the empty nucleus is subject to phonetic interpretation in certain well-defined circumstances. It is neither deleted nor inserted. Rather, it is present in the lexical representation and the context in which it occurs

determines whether or not it is phonetically realised.

With respect to the syllable structure in Korean, Heo (1995) and Rhee (2002) propose that Korean has neither branching onsets nor branching rhymes: Korean is a so-called CV-only language (cf. Lowenstamm 1996). Concretely, the vowel [ɨ] is represented by an empty nucleus and all surface consonant clusters are syllabified as two onsets separated by an empty nucleus. Furthermore, final single consonants are syllabified as an onset followed by a final empty nucleus, due to the effect of the 'Coda' Licensing Principle (Kaye 1990, Kaye, Lowenstamm, and Vergnaud (henceforth KLV) 1990) and the Onset Licensing Principle (Harris 1994), which are given below.

(11) (a) 'Coda' Licensing Principle
    A post-nuclear rhymal position must be licensed by a following onset.
    (b) Onset Licensing Principle
    An onset head position must be licensed by a nuclear position.

In the phonological literature, the notion of licensing is used as a relation that binds one unit to another. Each unit within a representation must belong to some higher-order unit (Selkirk 1984, McCarthy and Prince 1986, among others). Besides this hierarchical licensing, it has become customary to adopt a set of syntagmatic relations, which sanctions certain adjacent syllabic positions. (11) expresses such inter-constituent licensing relations: every onset requires a following nucleus, and every coda requires a following onsets. These two principles ensure that a final consonant is represented by an onset that is followed by an empty nucleus (cf. Harris 1994, Harris and Gussmann 1998). Thus, a word such as [kotɨrɨm] 'icicle' has the following lexical representation.

(12) /kotØLØmØ/ [kotɨrɨm] (Ø: empty nucleus)

```
O1   N1   O2   N2   O3   N3   O4   N4
 |    |    |    |    |    |    |    |
 x    x    x    x    x    x    x    x
 |    |    |         |         |
 k    o    t         L⁵        m
```

In (12), there are three empty nuclei, N2, N3 and N4. On the assumption that the phonetic realisation of empty nuclei is [ɨ] in Korean, how do these empty nuclei receive phonetic interpretation? The Empty Category Principle (ECP) accounts for these matters.

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[5] This paper will not deal with the topic of underlying liquids in Korean. It suffices to say that [r] occurs intervocalically and [l] occurs elsewhere. The underlying liquid is represented by the 'archiphonemic' L.

(13) Empty Category Principle (Kaye 1995, Rhee 2002)
   A licensed (empty) category receives no phonetic interpretation licensing under the following circumstances:
   a. when it is domain-final (parameterised).
   b. when it occurs within an inter-onset domain.

   The ECP basically says that an empty nucleus is not phonetically realised (i.e. it is inaudible), if it is licensed. The condition in (13a) is a parameter: some, but not all, languages license domain-final empty nucleus. Informally speaking, languages that have consonant-final words, such as English, Dutch, German and Arabic, license a final empty nucleus so that it is not phonetically manifested. However, in languages without consonant-final words, such as Hawaiian and Italian, a final empty nucleus is not licensed and so must be phonetically interpreted, i.e. words in these languages must end in a vowel. Korean allows consonant-final words, so that the parameter setting for (13a) is 'on' in this language.
   The notion of inter-onset government is responsible for the phonetic interpretation of internal empty nuclei, as in (13b). As with the final empty nucleus licensing, an internal empty nucleus is not phonetically realised when it is licensed; otherwise it is phonetically interpreted as the vowel [ɨ], as discussed earlier. Inter-onset government involves two onsets separated by an empty nucleus. To determine whether an internal empty nucleus is phonetically realised or not, the licensing conditions of inter-onset government in Korean are as follows (Rhee 2002).

(14) The Licensing Conditions on Internal Empty Nuclei

```
X       O1      N1      O2      N2      Y
        |       |       |       |
        x       x       x       x
        |       ↓       |       |
        α      [ø]      β       δ
        ↑_____↓
      inter-onset government
```
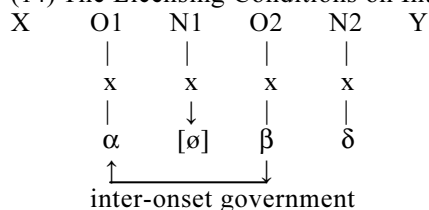
(a) N1 is licensed iff:
   (i) O2 governs O1
   (ii) An unlicensed government-licenser, i.e. N2, must be present.
(b) Governing hierarchy
   liquid < nasal, lax obstruent < aspirated or tense obstruent
(c) Government-licensing
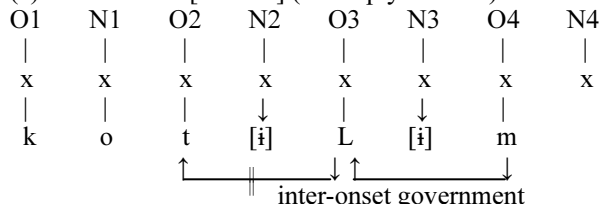   For a governing relation to hold between a non-nuclear head β and its complement α, α must be government-licensed by its nucleus.
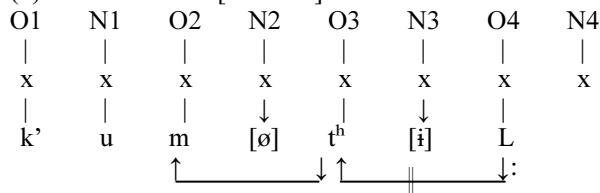   (Charette 1991: 101)

The notion of inter-onset government concerns a governing relation between the two onsets in question and determines the phonetic interpretation of an empty nucleus in between them. In (14a), if O2 governs O1 and N2 has phonetic content (i.e. is unlicensed), then N1 does not receive phonetic interpretation. Thus, N1 remains silent and the sequence of O1 and O2 is a well-formed coda-onset cluster on the surface. On the other hand, if O2 fails to govern O1, the intervening empty nucleus phonetically is realised as [ɨ]. In this case, the cluster in question does not constitute a well-formed consonant sequence. In order to meet the requirements of inter-onset government, a governing segment must have appropriate governing properties. The governing hierarchy in (14b) shows that aspirated and tense obstruents are the strongest, liquids are the weakest, and nasals and lax obstruents in between.[6] Thus, liquids can occur in governed position and aspirated and tense consonants can occur in governing position. In addition, government-licensing is required, in the sense that the governing onset O2 should be licensed by an unlicensed nucleus (i.e. one with phonetic content) in order to govern the preceding onset O1. Informally speaking, a surface coda-onset cluster requires a following vowel in Korean. If any of the conditions is not satisfied, the empty nucleus N1 receives phonetic interpretation. For the sake of concreteness, let us see how the ECP derives the phonetic form [kotɨrɨm] and [k'umtʰɨl] from underlying /kotØLØmØ/ and /k'umØtʰØLØ/ 'wiggling' into the phonetic forms, respectively.

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[6] Although a detailed discussion on the governing hierarchy among consonants in Korean is beyond the scope of the paper, some important notions relevant to this paper are briefly introduced. This paper adopts the view that the ultimate unit of segments is the monovalent element (KLV 1985, Harris 1990, Ploch 1999, among others). Thus, the contrasts among segments are represented by the presence/absence of relevant elements. There are two types of consonants with respect to governing properties. The *headed* segments possess governing properties and so can occur in a governing position to govern *headless* segments. Headed segments contain laryngeal properties such as [constricted glottis] and [spread glottis]. Informally speaking, headed segments such as tense and aspirated obstruents can govern headless ones such as lax obstruents and sonorants. Among headless segments, more complex segments can govern less complex ones. Segmental complexity is calculated in terms of the number of elements that a segment is composed of. In terms of segmental complexity, lax obstruents and nasals are treated as more complex than liquids. Accordingly, liquid + lax obstruent or liquid + nasal clusters are regarded as well-formed coda-onset clusters, as in (14b) above. For a detailed discussion on element-based consonant representations in Korean, see Rhee (2002, 2005).

(15) (a) /kotØrØmØ/ [kotɨrɨm] (Ø: empty nucleus)

```
O1    N1    O2    N2    O3    N3    O4    N4
|     |     |     |     |     |     |     |
x     x     x     x     x     x     x     x
|     |     |     ↓     |     ↓     |
k     o     t    [ɨ]    L    [ɨ]    m
                 ↑___‖___↓ ↑_____↓
                      inter-onset government
```

(b) /k'umØtʰØLØ/ [k'umtʰɨl]

```
O1    N1    O2    N2    O3    N3    O4    N4
|     |     |     |     |     |     |     |
x     x     x     x     x     x     x     x
|     |     |     ↓     |     ↓     |
k'    u     m    [ø]    tʰ   [ɨ]    L
                 ↑_____↓ ↑____‖____↓:
```

inter-onset government

On the standard assumption that the ECP proceeds from right to left in Korean, let us consider (15a). N4 is licensed parametrically (see above). Thus, the empty nucleus N4 cannot act as a government-licenser for the O4 to govern preceding O3 so that N3 is not licensed (i.e. must be audible), although the nasal in O4 can segmentally govern the preceding liquid in O3. With respect to the empty nucleus N2, the liquid in O3 cannot govern the lax stop in O2. Hence, N2 is not licensed either and this empty nucleus must also be phonetically realised. (15a) illustrates that the phonetic interpretation of both N4 and N3 is due to the absence of an unlicensed government-licenser and the failure of inter-onset government, respectively. In (15b), the liquid in O4 cannot govern the preceding aspirated stop in O3 so that the intervening empty nucleus N3 receives phonetic interpretation. Note that the empty nucleus N2 is licensed due to the fact that O3 can govern O2 and the unlicensed government-licenser N3 is present. In this way, the ECP controls the phonetic interpretation of empty nuclei.

On the basis of a formal account of the distribution of [ɨ], we will show in the next section that the presence of [ɨ] between identical lax consonants provides crucial evidence against the geminate hypothesis.

4. Against the geminate hypothesis

The geminate hypothesis assumes that a surface tense consonant is underlyingly represented by a sequence of lax obstruents. In the previous section, we observed that a well-formed consonant cluster lacks an intervening [ɨ]. If the geminate hypothesis is correct, it would predict that a sequence of lax consonants is well-formed, so that it does not trigger the appearance of [ɨ] between two identical consonants. Indeed, the vowel [ɨ] is

absent in true sonorant geminates in Korean, as shown below.

(16)　(a) liquid geminate
　　　　　[tuløle]　　　'girth'　　　　　[kəløle]　　　　'dust cloth'
　　　(b) nasal geminate
　　　　　[əmøma]　　'mom'　　　　　[ənøni]　　　　'sister'
　　　(c) /əmØma/ [əmma]
　　　　　O　　N1　　O2　　N2　　O3　　N3
　　　　　　　　|　　　|　　　|　　　|　　　|
　　　　　　　x　　x　　x　　x　　x
　　　　　　|　　　　　　　　　|　　　|
　　　　　　ə　　　　　　　　m　　a

As in (16 a, b), there is no "epenthetic" vowel [ɨ] between the two identical consonants so that these consonants form a well-formed cluster, as a result of their doubly-linked structure. In this configuration, the segmental content of O3 spreads to O2, i.e. O2 in the governed position is segmentally empty. In terms of inter-onset government, O3 can govern O2 and the government-licenser N3 is unlicensed so that the empty nucleus N2 does not receive phonetic interpretation. In other words, an empty nucleus within a doubly-linked structure is always licensed.

In the next section, we will discuss sequences of identical lax obstruents and see whether or not they behave in the same way as the sonorant geminates. We will deal with these sequences in internal and initial position in section 4.1 and 4.2, respectively.
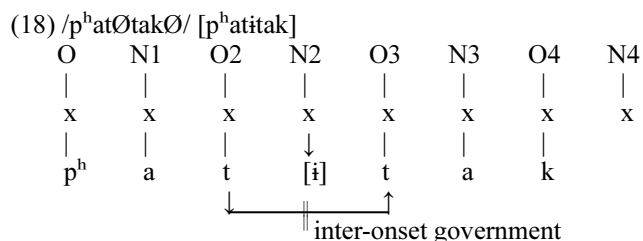
4.1 Internal lax obstruent sequences

As discussed earlier, a well-formed coda-onset cluster requires that a governing onset has the appropriate properties to govern a preceding onset and a following government licenser. But, when these requirements are not met, the vowel [ɨ] occurs between the two consonants in question. Bearing this in mind, let us consider whether or not a sequence of identical lax obstruents is well-formed in monomorphemic words.

(17)　Identical lax obstruent sequences[7]
　　　[ɨsɨsɨ]　　　　　'shivering'　　　[p'otɨtɨk]　　　'grinding'
　　　[pʰatɨtak]　　　'with a plop'　　[hwatɨtɨk]　　'with a bang'
　　　[c'ip'ut_ɨtɨ]　　'unwell'　　　　[atɨtɨŋ]　　　'bickering'

---

[7] The examples in (17) are mimetic words which may require a special treatment phonotactically. For instance, some mimetic words end in the vowel [ɨ], which violates the general phonotactic statement that this vowel does not occur in final position (cf. footnote 4). However, apart from final position, the phonotactic constraints on internal consonant clusters are observed, e.g. /calpʰak/ 'squelching'; /talpak/ 'with splash'; /teŋkɨl/ 'ringing', among others. Accordingly, these data do not constitute counterexamples to our discussion.

Note that sequences of bilabial and velar lax obstruents are missing.[8] Apart from these sequences, the vowel [ɨ] occurs between identical lax obstruents in the examples in (17). This strongly suggests that these clusters are not well-formed, so that they cannot be represented as genuine geminates. Put another way, it is not possible to represent them as a geminate in underlying representation. Accordingly, the data in (17) provides evidence against the geminate hypothesis which assumed that clusters of identical lax obstruents are allowed in the underlying representation. Accordingly, in comparison with the sonorant geminates in (16), the presence of [ɨ] indicates that these clusters cannot constitute a doubly-linked structure. In terms of inter-onset government in (14), the presence of [ɨ] in (17) implies that a lax obstruent cannot govern another lax obstruents, as shown below.[9]

(18) /pʰatØtakØ/ [pʰatɨtak]

```
      O      N1     O2     N2     O3     N3     O4     N4
      |      |      |      |      |      |      |      |
      x      x      x      x      x      x      x      x
      |      |      |      ↓      |      |      |      |
      pʰ     a      t      [ɨ]    t      a      k
             └──────────────╫──────────→
                       ‖inter-onset government
```

4.2 Initial lax obstruent sequences

Regarding the treatment of initial geminates,[10] recall that Han (1992) exploited Stray Erasure to delete one of the lax consonants in order to conform to the syllable structure constraints in Korean. Ahn and Iverson (2004), on the other hand, relied on the notion of Linking Constraint to preserve the sequence of identical lax obstruents (which are realised as tense on the surface). In this section, we argue against these analyses on the basis of the distribution of [ɨ]. Two instances provide empirical evidence against the presence of initial geminates.

(19) (a) [tɨtiə] 'at last'   [sɨsɨro] 'of its own accord'
     (b) [ɨmme] 'moo'

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[8] In the dictionary, [pɨ] and [kɨ] are present such as in [sinapɨro] 'gradually' and [palkɨre] 'reddish'. However, sequences of [pɨpV] and [kɨkV] (V: vowel) are absent in monomorphemic words. Although the reason why they do not appear requires further research, at present we assume that the absence of these sequences should be treated as an accidental gap.

[9] The same pattern is also noted among heterorganic lax obstruent sequences, e.g. [cintɨki] 'louse'; [hotɨki] 'reed pipe'; [itɨkəni] 'rather'.

[10] Note that the initial geminates exist in Austronesian languages such as Ponapean (Rehg 1981), Trukese (Davis 1999) and Leti (Hume et al. 1997), among others.

(19a) shows that the initial identical [t]s are separated by [ɨ]. This indicates that they do not constitute a legitimate geminate. Note that the occurrence of [ɨ] in this context is accounted for in the same way as in (18), i.e. one lax obstruent cannot govern another one.

(19b), on the other hand, demonstrates that another authentic geminate requires a preceding [ɨ] when it occurs initially. This implies that a well-formed geminate cannot occur in initial position without the support of a preceding [ɨ]. In other words, geminates can only occur in intervocalic position in Korean. Notice that the occurrence of geminates is somewhat parallel to that of coda-onset clusters. The distribution of the latter is also restricted to intervocalic position in that these sequences are allowed to appear neither initially nor finally, as illustrated in (9).

The constraint on the distribution of coda-onset clusters is further confirmed by loanword adaptation.

(20)   (a) final epenthesis of [ɨ]
        tent   [tʰentʰɨ]   *bank*   [pɛŋkʰɨ]
        camp   [kʰɛmpʰɨ]   *milk*   [milkʰɨ]
    (b) initial epenthesis of [ɨ]
        Mbeki   [ɨmbek'i]   *N'daw*   [ɨndau]
        Nguema [ɨŋgema]

We notice that epenthesis of [ɨ] in final and initial position mirrors the coda-onset clusters to locate intervocalically. In particular, the initial epenthesis is invoked before a partial homorganic geminate, as in (20b). Although the structure of the partial geminate is slightly different from that of the full geminate, the behaviour of [ɨ] in initial position involving the two types of geminates sufficiently provides sufficient evidence that geminates are not allowed to appear initially. Consequently, the treatments using Stray Erasure in Han (1992) and the Linking Constraint in Ahn and Iverson (2004), as mentioned above, are not adequate tools to account for the presence of initial geminates underlyingly.

4. Conclusions

This paper has dealt with the underlying representation of tense consonants, which has been one of the highly controversial issues in Korean phonology. We have argued against the geminate hypothesis, which assumed that tense consonants are underlyingly represented by a geminate lax obstruent. Unlike previous approaches, we have tried to achieve this goal on the basis of phonotactic constraints on well-formedness in Korean. The key point of our proposal is that the well-formed coda-onset clusters do not require a vowel [ɨ]. The geminate hypothesis would predict that the geminates do not require presence of [ɨ]. When we investigated these clusters, however, we found that the vowel [ɨ] does occur in these clusters. We offered a formal

analysis of the reason why the vowel [ɨ] separates the members of a geminate lax obstruent: one lax obstruent cannot govern another one.

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