

Reevaluating Syntax-to-Phonology Mapping in Korean: An Optimality-Acoustic Account *

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This paper offers an optimality-based revision of previous syntax-driven analyses for determining how prosodic constituency is derived from phrase structure in Korean. Under this revision, syntax-to-phonology mapping constraints (Selkirk 1987) appear to be outranked by a metrical constraint that idealizes minor phonological phrases as binary branching. This analysis accounts not only for data previously discussed in the literature on Korean phrasal phonology, but also for previously problematic data: the acoustic behavior of lax stops in existential expressions of the sort 'father(-NOM) exists'. Taken together, the theoretical discussion and the quantitative acoustic data under investigation reaffirm the notion that determining prosodic structure requires reference not only to syntactic information, but also to phonological conditions that constrain the nature of prosodic units.

1. Introduction

It is widely acknowledged that in Korean, underlying voiceless lax non-continuant obstruents are realized as voiced when surrounded by voiced segments (C.-W. Kim 1967, 1970; Kim-Renaud 1974; among others):

* This paper, which began as a presentation at the 1995 Meeting of the Linguistic Society of America in New Orleans, has since undergone a number of transformations. Many thanks to those who have contributed to this transformation, including Don Burquest, John Paolillo, audiences at the LSA and at the International Linguistics Center in Dallas, and two anonymous *Language Research* reviewers. As ever, all errors, omissions, shortcomings, and excessive liberty taken with the theory (especially as regards potential OT heresies) are fully my own. Support for work on this project has been partially provided by a Research Enhancement Seed Grant awarded by the College of Liberal Arts at the University of Texas at Arlington in 1993.

(1) UR	isolation	'this X- <i>nominative</i> '	
/pap/	[pap̚]	[ibabi]	'cooked rice'
/kuk/	[kuk̚]	[igugi]	'soup'
/tal/	[tal̚]	[itari]	'month, moon'

In subsequent investigations of Lax Stop Voicing (LSV), it has been argued that the process is postlexical; for example, LSV is not structure preserving (Korean has no phonemically voiced oral stops) and it occurs across word boundaries. LSV, however, may be sensitive to a range of linguistic conditions, including (but not limited to) syntactic structure, semantic and/or pragmatic information (in particular, focus), weight or length (in terms of number of syllables or pitch-accents), and prosodic constituency. (For a more fully elaborated discussion of such factors, see Jun 1993: 180ff, Shattuck-Hufnagel and Turk 1996, and Silva 1998.)

An examination of the literature on how phrasing is determined in Korean reveals two *general lines of analysis*. In the first, the domain for LSV (and other rules, such as pitch-accent adjustment) is determined on the basis of intonational contours. Jun (1990, 1993), for example, argues that LSV operates in the context of an accentual phrase, where accentual phrases are determined on the basis of observable peaks in the F₀ profile of an utterance. A second line of analysis is founded on the notion that the prosodic domains for processes such as LSV are determined primarily by making reference to the syntactic structure of an utterance. Y.-M. Y. Cho (1987, 1990) and Silva (1989, 1990, 1991), for example, argue that LSV operates within the domain of a phonological phrase (or in Silva's terminology, a "minor" phrase), which can be delineated in great part on the basis of syntactic phrase structure.

In this paper, analyses of the second sort – i.e. those that take the view that prosodic structure is essentially syntactically determined – are reconsidered and revised in the context of recent work in constraint-based Optimality Theory (OT). The analysis to be proposed here supports the notion that syntactic structure provides only part of information necessary for determining prosodic constituency, and makes explicit that non-syntactic factors may outrank syntactic factors in the determination of phonological phrasing. More specifically, it is shown that phrasal-binarity – condition left implicit in Y.-M. Y. Cho's and Silva's earlier work – plays a critical role in the determination of phrasal constituents.

In support of these theoretical claims, acoustic phonetic data regarding

LSV are presented with an eye toward understanding a situation that was not readily explained by previous syntax-driven analyses, namely the behavior of lax obstruents in two-word existential expressions of the sort in (2):

- (2) /apətʃika kjesjəs'ə/ 'Father-NOM exists-HONORIFIC'
 /apətʃi kjesjəs'ə/ 'Father exists-HONORIFIC'

Under the assumption that the two sentences in (2) manifest different phrase-structures (with the nominative-marked subject of (2a) in Spec of IP and the unmarked subject of (2b) underneath VP), both Y.-M. Y. Cho and Silva would predict distinct surface forms:

- (3) /apətʃika kjesjəs'ə/ → [ʰabəɸʝiga] [ʰkjesʝəs'ə]
 /apətʃi kjesjəs'ə/ → [ʰabəɸʝi gjesʝəs'ə]

However, acoustic analysis of the lax stop /k/ in the single-argument predicate /kjesita/ 'to exist (honorific)' shows this prediction to be incorrect. At the phrasal level, the sentences in (3) manifest identical prosodic constituency: one phonological phrase¹.

In the end, it is argued that the acoustic data provide further evidence that the constraints used in determining the structure of phonological phrases are not wholly syntax-dependent (see Selkirk and Tateishi 1988, 1991; Silva 1990). Rather, determinations of prosodic structure in Korean are hybrid in nature, taking their ultimate form partially based on the phrase-structure of the utterance while also conforming to syntax-independent constraints, such as those found in the phonological component of the grammar. Any account for determining prosodic structure, then, must embrace (to some degree) the concerns of researchers working in both the intonation-oriented and mapping-oriented camps.

2. Previous Accounts of Syntax-to-Phonology Mapping in Korean

Taking a cue from the previous literature regarding prosodic structure in Korean, we begin by considering the following sentential minimal triplet:

¹ Assuming that phrases in Korean are typically no longer than 5 or 6 syllables long in non-conversational speech (see Silva 1998), it is fully predicted that sentences similar to those in (2) and (3) but with longer subjects will force the formation of two phrases, thereby yielding a voiceless [k] in the verb.

- (4) (a) UR: / apətʃi + ka pəŋ + e tiləka + si + nta /
 father+NOM room+LOC enter+HONORIFIC+PLAIN
 Syntax: [IP [NP apətʃika] [VP [NP pəŋ] [v tiləkasinta]]]
 Prosody: [_φ apətʃika] [_φ pəŋ tiləkasinta]
 SR: [_φ abəɕʒiga] [_φ pəŋ dirəŋafinda]
 Gloss: 'Father enters the room'
- (b) UR: / apətʃi kapaŋ + e tiləka + si + nta /
 father bag + LOC enter+HONORIFIC+PLAIN
 Syntax: [IP [NP apətʃi] [VP [NP kapaŋ] [v tiləkasinta]]]
 Prosody: [_φ apətʃi] [_φ kapaŋ tiləkasinta]
 SR: [_φ abəɕʒi] [_φ kapaŋ dirəŋafinda]
 Gloss: 'Father enters the bag'
- (c) UR: / apətʃi kapaŋ + e tiləka + si + nta /
 father + bag+LOC enter+HONORIFIC+PLAIN
 Syntax: [IP [VP [NP apətʃi kapaŋ] [v tiləkasinta]]]
 Prosody: [_φ apətʃi kapaŋ tiləkasinta]
 SR: [_φ abəɕʒi gapaŋ dirəŋafinda]
 Gloss: '(e) enters Father's bag'

In (4), the strings of underlying segments for each of the three utterances are identical—/apətʃikapaŋetləkasinta/. It is argued here (as in the work of Y.-M. Y. Cho and Silva) that the observed differences in the phonological manifestations arise out of minor (but critical) differences in morphosyntax.² In (4a), the first /ka/ sequence marks the nominative case of /apətʃi/ 'father', while in (4b), the subject of the sentence is left unmarked (a viable option in the language) and the same /ka/ sequence functions as the first syllable of the locative-marked noun /kapaŋ/ 'bag'. In (4c), the sequence /apətʃikapaŋe/ is interpreted as a compound noun which functions as the direct object of the verb, thereby leaving the subject to be interpreted as null (e). These differences in morphosyntax result in different prosodic

² The relevant judgments are those of trained linguists, both native and non-native speakers alike. As demonstrated in Silva (1992), the percept of "voicing" in Korean is not directly correlated to the presence or absence of vocal fold vibration during stop closure. As shall be demonstrated below, these non-phonemic voiced segments manifest a number of consistent acoustic properties, including minimal aspiration and a variable degree of voicing during stop closure.

structures for the three utterances, which ultimately yield subtly distinct surface realizations.

Syntax-oriented analyses of LSV advanced by Y.-M. Y. Cho (1987, 1990) and Silva (1990, 1990, 1991) take different approaches for determining the domain over which LSV is agreed to operate. In her work, Y.-M. Y. Cho (1990) employs a relational approach:

- (5) Apply the following rules cyclically to all maximal projections, proceeding bottom up. At any given step (a) applies before (b). Let the maximal projection under consideration on a given cycle be M.
 - (a) If M branches, combine the head of M into a phonological phrase with all adjacent unphrased material, up to and including the closest XP, or if no such phrase is present, the left edge of M.
 - (b) Phrase any focused word with the next word, unless that word is already phrased.
 After (a) and (b) have applied in all possible environments, (c) applies.
 - (c) Unphrased words form P-phrases of their own.

In contrast, Silva employs an end-based approach, based on those developed in Chen (1987) and Selkirk (1986), claiming that LSV operates within minor phrases (φ):

- (6) • Major Phrase (Φ): {left, X^{\max} }
- Prosodic Word (ω): {left, X^{lex} }
- Minor Phrase Constraints (φ):
 1. Focus: A minor phrase may contain at most one focus-accented and two unaccented prosodic words.
 2. Directionality: In forming minor phrases, scan from left-to-right.

Under the approach in (6), the relationship between prosody and syntax is less direct, and includes a level of constituency between the phonological word (ω) and the major phonological phrase (Φ): the minor phrase (φ). First, major phrases and phonological words in Korean are delineated by referencing the left edges of maximal projections (X^{\max}) and minimal lexical projections (X^{lex}) in the syntax. Once these two prosodic levels have been mapped, an additional set of constraints within the phonology proper dictate the formation of the minor phrases. (See Selkirk and Tateishi 1988, 1991; Silva 1989, 1990.)

It can be argued that these two analyses of Korean are empirically similar, as each accounts for the facts equally well. Yet Silva (1990, 1992) argues the end-based approach is theoretically preferable in that it makes explicit the parameterizable nature of the mapping phenomenon (as suggested in a comparison of Korean and Japanese pitch-accent phenomena) as well as the relative contributions of two types of factors: those derived from syntactic structure and those that make reference to phonological (and also semantic) factors.

Of interest to the current discussion is the role of binarity in these two approaches. In Cho's approach, the notion that phrases are comprised of two word-level units (i.e. binarity) is implied. Per her algorithm (5), phonological phrases are constructed in a bottom-up manner, directly adjoining phonological words; the resulting tendency for binary-branching phrases can thus be seen as a reflection of the tendency for binary-branching syntactic constituents, prevalent in current phrase-structure analyses of Korean. In Silva's approach, however, the statement of binarity is made explicitly: the second conjunct of the "Focus Constraint" organizes phonological words into binary branching units (i.e., Φ) within major phrases (Φ), provided there is no marked focus on any of the constituents. Such a condition can be attributed to more general principles of metrical constituency, inasmuch as binary branching units could be argued as preferable to non-branching (degenerate) units.³

Whether implicit or explicit, the issue of binary-branching phrases becomes critical when considering recursively left-branching constituents, such as utterances containing embedded clauses.⁴ Consider the example in (7), from

³The extent to which one might embrace the possibility of ternary-branching phrases or "unbounded" phrases is left for speculation. The evidence pertaining to Korean phrasing, however, appears to lend give some primacy to binary-branching constituents. See also Silva (1998).

⁴Silva (1990) argues that the end-based approach is successfully applied to three different varieties of Korean: Seoul, Kyōngnam, and Chōnnam. In adapting Selkirk and Tateishi's analysis of Japanese to the Korean data, we provide a direct means of understanding some of the typological similarities between the two languages. For example, it can be argued that while minor phrase formation in Japanese is constrained by phonological conditions (among them a condition on the number of pitch-accented element that may occur in a minor phrase), minor phrase formation in Korean is completed prior to the application of pitch-accent rules. In reanalyzing data from both the Kyōngnam (Jung 1988) and Chōnnam (Jun 1900, 1993) dialects, Silva claims that first minor phrases are constructed and only then are tone sandhi

constraints allow for the interpolation of the intermediate level of structure, thereby creating three binary branching minor phrase constituents within which LSV operates.

The question that remains to be more fully understood is the nature of this apparent binarity condition in the formation of phrasal constituents. Is it an artifact of the inherent binarity of the structural relation between a head and its adjacent complement (as suggested by Y.-M. Y. Cho) or is it a phonological condition on prosodic structure (as suggested by Silva)?

3. An Optimality-Oriented Approach to Prosodic Constituent Formation

Before proceeding to a discussion of the phonetic details regarding LSV, let us consider a preliminary reworking of proposed syntax-to-phonology mapping presented above, taking advantage of the constraint-based framework developed in work such as Prince and Smolensky (1993), McCarthy and Prince (1993), and Selkirk (1995). Taking the end-based algorithms above as starting point, one can posit the following two alignment constraints, one each for Major Phrases and Prosodic (Phonological) Words:

(8) ALIGN (L, Φ ; L, X^{\max}): In delineating major phrases (Φ), align each left edge of a maximal projection in the syntax (X^{\max}) with the left edge of Φ .

ALIGN (L, ω ; L, X^{lex}): In delineating prosodic words (ω), align each left edge of a lexical projection in the syntax (X^{lex}) with the left edge of ω .

In each case, the intent of the alignment constraint is to ensure a congruity between “syntactic edges” and “phonological edges”; as such it is assumed here that the alignment constraints given in (8) are met only when there is a one-to-one mapping of designated category edges (from the syntax) and prosodic domains edges (in the phonology).⁵

⁵ Whether the interpretation of the constraint in this manner seriously conflicts with or confounds the established premises of alignment constraints as developed in OT is of minor concern to me. In the absence of data that forces a set of matching constraints—one to check the alignment of each Φ with respect to X^{\max} and another to verify that each X^{\max} is associated with a Φ —I interpret the alignment constraints as stated herein.

Of primary interest here is ALIGN (Φ): It not only presents itself as an OT-style “translation” of the mapping algorithm in (6), but it captures the implicit limits on the domain for phonological phrasing present in the relation-based approach (5). These limits are expressed by the specification of the domain ‘M’ being a “maximal projection,” and the way in which syntactic heads are conjoined with unphrased adjacent complements (which in Korean, will always lie to the left) in cyclic manner. In addition to these two constraints, let us add a third, one that explicitly accounts for the binary-branching nature of minor phrases (φ):

(9) φ -BIN: Minor Phrases are binary branching.

This binarity constraint makes explicit that fact that the optimal structure for an utterance is one which contains at least one branching minor-phrase (i.e. a minor-phrase dominating at least two P-words). This last constraint works in concert with yet one more alignment statement:

(10) ALIGN (L, φ ; L, Φ): In delineating minor phrases (φ), align each left edge of φ with the left edge of Φ .

This constraint ensures that minor phrases are optimally associated with the left edge of their prosodic mothers.

These constraints work together in accounting for the prosodic structure for the sentence types discussed by Y.-M. Y. Cho and Silva, including single object ([_{NP} S] [_{VP} [_{NP} O] V]) and embedded structures such as that in Figure 1 ([_{VP} [_{NP} [_{IP} [_{VP} [_{NP} N₁] V₁]] N₂] V₂]). In the tableau below, I have omitted a column for ALIGN (ω), as it is not directly relevant to the discussion at hand. First we consider SOV sentences, as in (11).

(11)

		φ -BIN	ALIGN (Φ)	ALIGN (φ)
⇒	a	[φ [φ S]] [φ [φ OV]]	*	
	b	[φ [φ S]] [φ [φ O] [φ V]]	**!*	*
	c	[φ [φ SO] [φ V]]	*	*!
	d	[φ [φ SOV]]	*	*!

In (11) we find that the optimal candidate exhibits a single violations of φ -BIN (by virtue of the single-word subject phrase), but conforms to both alignment constraints. The remaining three candidates are problematic in

that they contain multiple non-branching minor phrases (11b), or that they exhibit misalignments at the level φ or Φ . The tableau in (11), however, does not necessarily indicate a crucial ranking among the candidates. For this we turn to the tableau in (12).

(12)

		φ -BIN	ALIGN (Φ)	ALIGN (φ)
a	$[\varphi [\varphi N_1 V_1 N_2 V_2]]$	*!		
b	$[\varphi [\varphi N_1 V_1]] [\varphi [\varphi N_2 V_2]]$		*!	
⇒ c	$[\varphi [\varphi N_1 V_1]] [\varphi N_2 V_2]$			*

(12) indicates that minor phrase alignment is subordinate to φ -BIN and ALIGN (Φ), but does not help to determine a ranking between these two higher-ranked constraints.⁶

In addition, the ranked constraint approach to prosodic domain assignment helps to clarify an otherwise thorny problem for both Cho and Silva: the fact that Adv-Adj-N constructs of the sort /aʃu tʃoin tʃip/ ‘very good house’ appear to form a single domain for LSV, i.e., one minor phrase, thereby yielding [aʃu tʃoin tʃip].⁷

(13)

		φ -BIN	ALIGN (Φ)	ALIGN (φ)
a	$[\varphi [\varphi Adv]] [\varphi [\varphi Adj N]]$	*	*!	
b	$[\varphi [\varphi Adv Adj]] [\varphi [\varphi N]]$	*	*!	
⇒ c	$[\varphi [\varphi Adv Adj N]]$	*		
d	$[\varphi [\varphi Adv]] [\varphi Adj N]$	*		*!
e	$[\varphi [\varphi Adv Adj]] [\varphi N]$	*		*!

As seen in (13), any combination of an odd number of phonological words

⁶Cf. Silva (1998), however, in which it is argued that ALIGN (Φ) outranks φ -BIN. Both there and here, it is fully understood that the optimal outputs as presented in this (and subsequent) tableau may be altered by the inclusion of pragmatic and discourse effects imposed by a speaker under certain circumstances. The assumption made in this paper is that under ‘neutral’ conditions, the tableau represent speakers’ preferred phrasing. See Silva (1998) for a more fully elaborated quantitative account of speakers’ rankings of so-called “neutral” SOV utterances.

⁷Here we assume the following syntactic structure: $[_{NP} [_{AP} [aʃu] [tʃoin]] [tʃip]]$, where ‘AP’ could just as well be taken as a CP/IP complex, given the verbal nature of Korean adjectives. This detail is not to obscure the key fact that in this construction, all maximal projections in the syntactic structure will find themselves on the left edge, thereby forcing a single major phrase (in the best of generated outputs).

will produce at least one violation of \emptyset -BIN. As such, violations of other constraints will determine the optimal candidate. Here we find the winner to be a single minor phrase dominated by a single major phrase, (13c).

4. Phonetic Correlates of LSV

In instrumental analyses of stop voicing in Korean, both Jun (1990, 1993) Silva (1992) have argued that LSV is not a case of phonological assimilation or feature spreading, but rather a phonetic rule of voicing interpolation. Silva (1992), for example, explains the apparently variable nature of LSV within the context of a prosodic hierarchy determined primarily by the syntax-to-phonology mapping algorithm outlined in §2 above. In doing so, it has been noted that LSV is routinely blocked in some circumstances (e.g., between a subject NP and the following VP as in [abəɕʝiga/paŋe...] and [abəɕʝi/kabaŋe...]) but is obligatory in others, specifically within a phonological word (e.g., /apəɕʝi/ → [abəɕʝi]). In a third set of cases, however, judgments regarding voicing are less consistent: perceived application of LSV is clearly favored but not obligatory. For example, the data in (2) are most likely rendered with perceptible voicing between the object and the verb—[kabaŋe ɕirəgafinda], but an alternate pronunciation in which voicing does not seem to apply is likewise acceptable—[kabaŋe tirəgafinda]. As such, Silva may define three distinct prosodic positions relevant to the LSV rule:

- (14) (a) The position at the left edge of a minor phrase and the edge of a phonological word (phrase-edge or PE); in this position, lax stops are typically considered to remain voiceless.
- (b) The position within a minor phrase but at the edge of a phonological word (word-edge or WE); in this position, lax stops are typically considered voiced, though judgments vary considerably.
- (c) The position within a phonological word (word-internal or WI); in this position, lax stops are typically considered voiced.

These positions are illustrated in (15).

$$(15) \quad [\varphi \text{ a b } \text{ə} \text{ɕ} \text{i}] [\varphi \text{ k a b a } \eta - \text{e} \left\{ \begin{array}{l} \text{t} \\ \text{d} \end{array} \right\} \text{ i r } \text{ə} \text{g a} \text{f i n d a}]$$

$$\begin{array}{cccccc} \uparrow \uparrow & & \uparrow \uparrow & & \uparrow & & \uparrow & & \uparrow \\ \text{WI WI} & & \text{PE WI} & & \text{WE} & & \text{WI} & & \text{WI} \end{array}$$

More recent instrumental analyses (T. Cho 1996; J.-I. Han 1995; Jun 1990, 1993, 1995; M.-R. Kim 1994; Y. Kim 1995) shed additional light on the voicing phenomenon in Korean, particularly the apparent variable nature of the voicing judgments in word-edge position. Despite the difficulty in making consistent perceptual judgments regarding voicing in WE position, one finds that the acoustic properties relevant for judging voicing—including the voicing during stop closure and post-release aspiration—are consistent across speakers. Moreover, the values for each acoustic parameter vary systematically but consistently in each of three prosodic positions outlined in (14). These relative values are summarized in (16), taken from Silva (1992).

(16) Prosody Effects on the Acoustic Properties of Lax Stops (Silva 1992: 131)

	PE	WE	WI
Duration of Stop Closure	long	mid-range	short
Duration of Voicing in Closure	←	shorter →	longer
Percentage of Closure Voiced	small	mid-range	large
Aspiration	long	mid-range	short

From this table we see that position within the prosodic structure of an utterance has an effect on the acoustic characteristics of lax stops, such that PE position is associated with longer, less sonorous segments, WI position with shorter, more sonorous segments, and WE position somewhere in between. In short, there appears to be a prosodically-based hierarchy of *consonantal strength* (à la Escure 1977), as *presaged* by Kim-Renaud in 1974: PE > WE > WI.

5. The Acoustic Research Question

The phrasing algorithms outlined in §2 make interesting predictions regarding the nature of one-place predicates in Korean, illustrated in Figure 2a. The VP-internal argument of the existential predicate is moved to the

SPEC of IP, where it receives its nominative case marking (H.-S. Han 1987: 45 ff). Thus we predict that such a sentence will consist of two major phrases and two minor phrases. As such, it is follows that voicing sandhi should be blocked, as the target /k/ sits in PE position. By contrast, sentences in which the single argument is left *in situ*—and does not acquire a subject marker—are predicted to form a single major phrase and a single minor phrase with the verb, as in Figure 2b. The same sentence with a VP-internal subject should exhibit voicing characteristics of the sort associated with phrase internal (“WE”) lax stops.⁸

(a) with nominatively marked argument (b) with unmarked argument

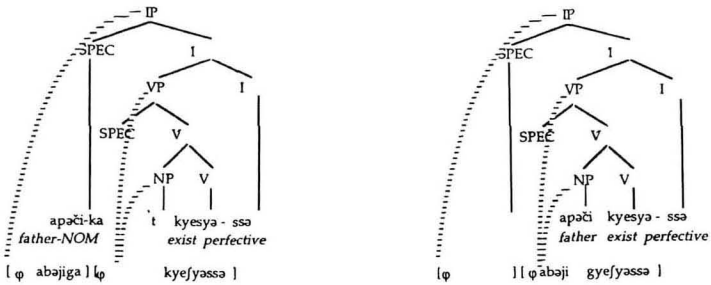


Figure 2. Predicted Prosodic Structure for Existential Predicate Utterances. In (a), ‘father’ is nominatively case marked; in (b), it is not.

As we shall see, however, these predictions are not supported by the acoustic data; rather, they support the constraint-based approach presented in §3.

6. Methodology

The data for this study come from two male speakers of standard Korean,

⁸ While the discussion that follows speaks specifically to the relationship between the existential predicate /kjesita/ and its single argument (here ‘father’, the use of /kjesita/ is intended to be representative of the larger class; the line of argumentation developed is intended to be generalized to a range of single-argument predicates in Korean.

both students at an American university, and both in their twenties.⁹ After being comfortably situated in a sound-attenuated chamber, the speaker was presented with a set of cards, each containing a short sentence rendered in native Korean script (*hangül*). The test sentences included tokens in which the lax velar stop /k/ was produced under the three prosodic positions as described in Silva (1992): PE, WE, WI. In addition, speakers also read the sentences illustrated in Figures 2a and 2b, those exhibiting the single place existential predicate.

After reviewing the cards, the speaker was instructed to read each card aloud at a self-selected speed that was a "natural, comfortable speed— not too slowly." When a speaker either misread a card or inserted undue pauses, he was asked to repeat the sentence before continuing to the next. Each time the speaker completed the set of cards, the deck was shuffled and the cards were read again, for a total of five rounds. The interviews were recorded using a Marantz cassette recorder and a Sennheiser microphone at a standard tape speed (7.5 ips). The data were digitized on a Macintosh using an Impulse digitizer at a sampling rate of 8,000 samples/second. For each token, wave forms and spectrograms were created using Signalize™ speech processing software.

7. Results

Drawing on the analysis of stop voicing data found in Silva (1992), the acoustic features analyzed here are those most closely associated with stop voicing percepts in Korean: 1) duration of stop closure; 2) duration of vocal cord vibration during closure; 3) post release aspiration; and 4) percentage of stop closure that is voiced.

Table 1 contains the acoustic data for the realization of lax /k/ in the three 'test' positions (PE, WE, and WI) for speakers 1 and 2. These data array themselves in the pattern presented above in (16), with lax stops being realized less sonorously in PE position and more sonorously word-internally.

⁹It must be noted that the two speakers discussed in this paper were also participants in the study presented in Silva (1992), an analysis of five male speakers; as such, it is no surprise that the data in Table 1 conform nicely to those reported in Silva (1992).

Table 1. Acoustic Data for the Realization of Underlying /k/ in Three Prosodic Positions

In each cell, the first number represents a mean score for five repetitions; the number in parenthesis is the standard deviation. Note that the clearest pattern to be discerned for both speakers is the relationship between prosodic position and aspiration: as the target segment lies further from a phrasal edge, the degree of aspiration decreases. All duration values are given in milliseconds (ms).

	Speaker 1			Speaker 2		
	<u>PE</u>	<u>WE</u>	<u>WI</u>	<u>PE</u>	<u>WE</u>	<u>WI</u>
Duration of Stop Closure	40 (5)	34 (11)	37 (3)	61 (4)	55 (9)	40 (3)
Duration of Voicing during Closure	9 (1)	12 (3)	14 (3)	10 (3)	3 (4)	40 (3)
Percent of Closure that is Voiced	22.6 (4.4)	41.8 (32.8)	36.0 (5.3)	16.4 (4.8)	5.1 (6.9)	100.0 (0)
Duration of Aspiration	59 (9)	47 (15)	19 (8)	72 (15)	63 (20)	2 (4)

Table 2 displays the values for the acoustic parameters of /k/ in the two existential sentences. (See also Figure 3.) Comparing tokens of the types in Figure 2a and Figure 2b within speakers (via Student's t-test), one finds that the duration of closure, vocal cord vibration during closure, and aspiration were not significantly different at the level $p \leq 0.05$. These results do not support the predictions put forth above: in the cases of the existential verb sentences, the acoustic properties associated with voicing do not differ depending on the presence of the subject marker.

Table 2. Acoustic Measurements for /k/ in Existential Predicates
Items labeled 'Fig. 2a' include nominative marker; those labeled 'Fig. 2b' do not.

In each cell, the first number represents a mean score for five repetitions; the number in parenthesis is the standard deviation. All duration values are given in milliseconds (ms).

	Speaker 1		Speaker 2		1 & 2 Pooled*	
	2a (-ka)	2b (-ø)	2a (-ka)	2b (-ø)	2a (-ka)	2b (-ø)
Duration of Stop Closure	43 (7)	40 (10)	54 (11)	50 (8)	<i>n.a.</i>	<i>n.a.</i>
Duration of Voicing during Closure	16 (3)	19 (5)	23 (5)	24 (15)	19 (5)	22 (11)
Percent of Closure that is Voiced	38% (7%)	48% (7%)	43% (7%)	50% (30%)	40% (7%)	49% (22%)
Duration of Aspiration	32 (5)	31 (4)	44 (9)	50 (15)	<i>n.a.</i>	<i>n.a.</i>

* The columns for 'pooled data' include the combined data for subjects 1 and 2. Student's t-tests reveal no significant difference in the data for Voicing during Closure ($p > 0.120$) and Percent Voicing ($p > 0.680$), but that the speakers do differ significantly in terms of Duration of Closure ($p = 0.011$) and Aspiration ($p = 0.001$). Within-speaker differences between the Fig. 2a sentences and the Fig. 2b sentences, however, are not significant; in each case, $p > 0.1200$. So while each speaker may manifest some degree of idiosyncratic behavior in terms of the exact duration of any given phonetic event, we find that both speakers consistently treat the two sentences as if they possessed the same prosodic structure.

8. Discussion

The results suggests that the prosodic structure of both sentences in Figure 2 are identical. Moreover, a comparison of these measurements with those of in Table 1 seems to indicate that this common structure to be a single minor phrase: [_φ abəʒi(ga) gje:fjæssə]. While such a conclusion is to be expected for those sentences without a nominative case marker (Figure 2b), it poses a serious problem for a syntax-to-phonology-based analysis of the case-marked utterance (Figure 2a), in which one might have expected two non-branching major phrases and two corresponding minor phrases. Under such a scenario, it follows that the acoustic characteristics for the target stop /k/ would more closely resemble those of a Phrase Edge segment,

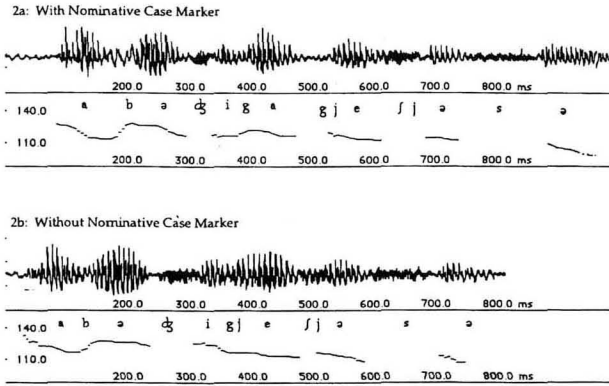


Figure 3. Representative Waveforms and Pitch Tracks for the Sentences in Figure 2. In 2a (top) ‘father’ is nominatively case marked; in 2b (bottom), it is not. Note that in both cases, there is one peak located at the left edge of the utterance, indicating a single accentual phrase. (Speaker 2)

with a lower percentage of voicing during stop closure and a higher degree of aspiration. Such is not the case.

Under the assumption that the syntactic structures presented in Figure 2 are valid, consider the alternative analysis presented in the following two tableaux:

(17)		/‘father’-NOM ‘exists’/	Φ -BIN	ALIGN (Φ)	ALIGN (φ)
	a	[ϕ [φ apəʃfika]] [ϕ [φ kjesjə]]	*!*		
	b	[ϕ [φ apəʃfika] [φ kjesjə]]	*!*	*	*
⇒	c	[ϕ [φ apəʃfika kjesjə]]		*	

(18)		/‘father’-Ø ‘exists’/	Φ -BIN	ALIGN (Φ)	ALIGN (φ)
	a	[ϕ [φ apəʃfi]] [ϕ [φ kjesjə]]	*!*	*	
	b	[ϕ [φ apəʃfi] [φ kjesjə]]	*!*		*
⇒	c	[ϕ [φ apəʃfi kjesjə]]			

In both (17) and (18), candidates consisting of two phrases exhibit two violations of Φ -BIN, while the preferred candidate—that with a single, binary-branching phrase—does not. Thus we see that the binarity constraint is crucial in evaluating which of the potential outputs is optimal. Although

Under the assumption that \emptyset -BIN dominates in the selection of the optimally structured candidate, we would predict the voicing patterns given above.

Unfortunately, analysis of precisely these two utterances yields contradictory results. Multiple repetitions of (19a) and (19b) as spoken by a male native speaker of Korean (who was not included in the earlier studies) reveals lenition effects throughout each string. The /k/ of /kjesinɪn/, for example, is consistently voiced and relatively aspiration-free; the /k/ of /kos/, moreover, is more often than not lenited to the point that it loses its obstruent characteristics and instead is manifest as a glide-like segment. Interestingly enough, evidence of this sort of extreme lenition in the case of velar segments was observed several times by Silva (1992). Of particular note is the fact that such extreme lenition occurred only within the bounds of a phonological word. This suggests that in the cases above, the lexical item /kos/—which serves as a ‘dummy noun’ indicating location—is perhaps analyzable as an enclitic element. Under such an analysis, both strings would then be analyzed as comprising only two P-words (‘father’ and ‘existing-place’), a situation would, in turn, invoke phrasal restructuring and ultimately allow for the voicing of the /k/ in /kjesinɪn/. Clearly, more work needs to be done in order to better understand not only the segmental and prosodic structure of such an utterance, but also the syntactic, lexical, and semantic aspects of the same.

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Appendix

Sentences used to elicit data appearing in table 1. Items are rendered in Yale Romanization. Target segments are underlined. As per claims set forth in Silva (1992), minor phrases are delineated by brackets.

Phrase Edge (PE): [ku key] [kanilako hay]
 'That thing is called a liver'

Word Edge (WE): [kuka] [sakwa kakkwucio]
 'He chopped up the apple'

Word Internal (WI): [ku key] [cakalilako hay]
 'That thing is called gravel'

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