

# SYLLABLE STRUCTURE EXPERIMENTS IN KOREAN, TAIWANESE AND ARABIC

Bruce L. Derwing,  
U of Alberta, Canada  
Dilworth B. Parkinson<sup>1</sup>  
BYU, U.S.A.

Sook Whan Cho & Yeo Bom Youn,  
Sogang U, Korea  
and H. Samuel Wang  
National Tsing Hua U, Taiwan<sup>1</sup>

## 1. BACKGROUND

The experimental investigation of syllable structure began with the work of Treiman [1,2, etc.], who used a variety of string manipulation tasks (notably word-blending) to determine whether such hypothesized units as the onset, rime or coda were viable for English. Dow [3,4,etc.] continued this work, using primarily a unit-substitution (and deletion) task. Taken together, this research lent support to the idea that English syllables have an onset+rime or right-branching structure.<sup>2</sup> Treiman & Danis [6], using an oral string-inversion and a written slash-insertion task, have recently extended this investigation to the question of syllable boundaries in English, putting such notions as the Maximal Onset Principle to experimental test. A chief purpose of the present study was to extend or adapt the methodologies developed in these English language investigations to other languages of diverse types, in order to explore the question of the universal generality of the findings.

For a variety of both practical and theoretical reasons, the first languages selected for the cross-

<sup>1</sup>The research reported here was supported by a research grant from the SSHRC (No. 410-88-0266), awarded to the first author. The authors also thank G.E. Wiebe for her technical assistance.

<sup>2</sup>More recent work has suggested an alternative interpretation that is less hard and fast (see [5]).

linguistic extension of these investigations were (1) Taiwanese, a language spoken widely throughout the island of Taiwan,<sup>3</sup> which is one of the few variants of Chinese that has a substantial number of postvocalic or coda consonants;<sup>4</sup> (2) colloquial Arabic, as spoken in Cairo, Egypt; (3) Blackfoot, an Algonquian language spoken on and around the Blood Reserve in southern Alberta, Canada; and (4) Korean, as spoken in and around the area of Seoul. The original focus of the investigation was to seek counterparts in these languages of some of the same structural units that had emerged from the English investigations (such as the onset, rime, nucleus and coda), as well as to clarify the question of syllable boundaries in these languages.

The initial data collection attempts were subsequently made in I-lan, Taiwan (for Taiwanese) in February of 1990; in Cairo, Egypt (for Arabic) in May and June of that year; and in Lethbridge, Alberta, Canada (for Blackfoot) in July and August. In each case the attempt was made to adapt directly the same unit-substitution (US) and string-inversion (SI)<sup>5</sup> tasks that had worked particularly well for English. Our initial attempts were extremely disappointing, however, as our pilot subjects in each of the first three languages listed above had great difficulties with both techniques, failing either to understand the tasks at all, even after multiple promptings, or yielding data that were chaotic and

<sup>3</sup>This language is a variant of South Min, which originated in the southern part of Fukien Province.

<sup>4</sup>Specifically, these consonants are the stop series /p,t,k/ and the corresponding nasal series /m,n,ŋ/, as well as the glottal stop in some dialects (but not in the one tested here). To allow for the testing of subjects from different dialect areas, words were avoided that exhibited dialectal features (such as initial /z/) that were known to vary throughout Taiwan.

<sup>5</sup>No string-inversion or other syllable-boundary task was envisaged for Taiwanese, as the problem of syllable division is a trivial one in that language.

uninterpretable. Before we even attempted to explore the Korean case, therefore, it had already become clear that some new or at least greatly modified techniques were going to have to be developed if the project was to progress any further.

## **2. THE CROSS-LINGUISTIC EXPERIMENTAL ASSESSMENT OF SYLLABLE CONSTITUENTS**

The purpose of the US task, as noted above, was to yield information about the full range of hypothesized intra- or sub-syllabic units (see [4] for a convenient summary). However, among the various hypothesized constituent elements of syllables, the onset and the rime have a particularly important status, both from the standpoint of empirical support and theoretical prominence. (Some claims have been advanced, in fact, that these two categories might even be universal.) If it was impractical at this stage to collect good information about all of the various subcomponents of syllables, therefore, an alternative that might clarify the primary break point was the next most appealing prospect.

From this perspective, Treiman's word-blending task was an attractive possibility, since it had already been successfully employed in English for this purpose.<sup>6</sup> From a purely practical standpoint, however, this task also shared a common handicap with the more ambitious US technique, in that both were production tasks that required the eliciting of individual responses from individual subjects, at enormous cost in time and effort for subjects and experimenters alike. Restricting the main question of interest in all these languages to the direction of the primary bonding between the vowel and adjacent consonants, therefore, we decided to try a forced-choice version of this task that could be group administered.

### **2.1. The Forced-Choice Word-Blending Task. Two**

<sup>6</sup>As the authors note, the results using this technique were rather less successful in assessing the status of 'lower' units, such as the nucleus (peak) and the coda.

versions of this task were developed and were validated for English, as illustrated below. In both cases, a series of monosyllabic real words are presented as input and the four possible first-order blends are offered for selection as output, two based on a primary break occurring before the vowels (the "On + Ri" blends) and two based on a primary break after it (the "He + Co" blends).<sup>7</sup>

### 2.1.1. Four-Choice version (Written Choices Only)

In this version of the test, the subjects hear a pair of input words and are asked to choose which of the four blends they prefer, selecting from a set of written responses. Four examples from an English form of this test are indicated below. For convenience, the two On + Ri blends are underlined, with the He + Co blends left unmarked.

1. PACK + DOG -> (a) POG (b) DACK (c) PAG (d) DAWK
2. GOOSE + SHADE -> (a) GADE (b) GUDE (c) SHOOSE (d) SHACE
3. BOOT + COVE -> (a) BOOVE (b) BOVE (c) COOT (d) COAT
4. POUND + JOIST -> (a) JOIND (b) POUST (c) JOUND (d) POIST

One advantage of this version of the test is that it permits the very rapid collection of a large body of data, since the test cannot only be group administered, but all four possibilities are handled at once for each input word-pair, yielding a relatively large amount of data from a relatively short test - a particularly valuable feature for pilot work. However, this form of the test also suffers from some potentially serious defects related to problems of control: (1) it places a relatively high burden on short-term memory, possibly biasing the results in favor of early responses; (2) it introduces a possible bias in favor of the linear or left-to-right ordering of parts; and (3) it rather

<sup>7</sup>Abbreviations: On(set), Co(da), Ri(me) [= Nucleus/Peak + Coda], He(ad) [= Onset + Nucleus/Peak].

arbitrarily forces subjects to choose between two blends of the same type. As with any other forced-choice variant of this task, care must also be taken to control for the possible effects of real word frequency.

### 2.1.2. Two-Choice Version (Oral or Written Choices)

In order to better control some of the extraneous factors introduced in the four-choice version of this task, a comparable two-choice version was also developed. In this version, the four possible first-order blends of each input word-pair are scattered over four different test items, randomly distributed throughout the test, as illustrated by the four examples provided below.

1. (a) SMORG + BLAND -> SMAND (= On + Ri)  
 (b) SMORG + BLAND -> SMOND (= He + Co)
2. (a) SMORG + BLAND -> SMOND (= He + Co)  
 (b) SMORG + BLAND -> SMAND (= On + Ri)
3. (a) BLAND + SMORG -> BLORG (= On + Ri)  
 (b) BLAND + SMORG -> BLAIRG (= He + Co)
4. (a) BLAND + SMORG -> BLAIRG (= He + Co)  
 (b) BLAND + SMORG -> BLORG (= On + Ri)

Directionality effects are controlled here by presenting the input words in both orders, allowing all responses to be composed of the first part of the first input word and the second part of the second. Order of choice biases are also controlled for here by presenting each blending type both as choice "(a)" and as choice "(b)", on different items. One consequent disadvantage of this approach is that it results in a test that is longer (in this case four times longer) than its corresponding four-choice counterpart would be, but the associated increase in control seemed worth this sacrifice. Moreover, this form of the test also greatly reduces the STM memory effects noted in connection with the four-

choice version, allowing for the possibility of purely oral as well as written responses.

When presented to English subjects, both versions of this test confirmed Treiman's result, by showing a general preference for onset-rime over head-coda type blends, though, as expected, this result was clearer using the two-choice rather than the four-choice version (see [7] for details).

## 2.2. Application to Taiwanese.

In our Taiwanese investigation, only the two-choice version of the forced-choice word-blending task was used. Specifically, in the key test items, subjects were given two alternative 'blendings' of a pair of Taiwanese words, one which combined the onset of one with the rime of the other and a second which combined the head of one with the coda of the other, as illustrated in the following example: (a)  $SAN^1 + CIM^1 \rightarrow SIM^1$  and (b)  $SAN^1 + CIM^1 \rightarrow CIN^1$ .<sup>8</sup> Notice that choice "(a)" in this case is an On + Ri blend, while choice "(b)" is a He + Co combination. Counterbalancing orders of stimuli and response-types were employed, and answers were written on answer sheets in Chinese characters. Also included on the test were several word pairs like the following, where both choices were of the On + Ri type and any preferences would presumably only indicate a response bias of some sort: (a)  $TA^5 + PI^5 \rightarrow TI^5$  and (b)  $TA^5 + PI^5 \rightarrow PA^5$ . By comparing the results on these 'no (systematic) choice' items with those from the first group, we were in a position to assess whether there was a distinct preference for blends of either the onset-rime or head-coda type on those items where this choice was made available.

The forced-choice word-blending task was conducted in Taiwan in November 1990 and in January 1991, yielding 95 subjects in all. All subjects were undergraduate students registered in Arts and Science at the National Tsing Hua University, Hsinchu, Taiwan, and all were native speakers of Taiwanese. Unfortunately, despite the

<sup>8</sup>The superscript numbers here indicate tone.

large number of subjects tested, no distinct preference emerged in favor of either onset-rime or head-coda blends, as responses to the 'choice' and 'non-choice' items were indistinguishable: in both cases responses were essentially random, except for a slight overall bias in favor of choosing response "(a)" over response "(b)". This presumably means one of two things: (1) on the one hand, it is quite possible that our subjects did not understand the nature of the task or were otherwise unable to perform it reliably under the conditions provided, or else the results were perverted by some extraneous factor that we failed to notice or control; (2) alternatively, however, the very real possibility also exists that performance was essentially random for a very good reason, namely, because the tiny mono-syllables of this language, involving no consonant clusters and rather strict internal collocational constraints, are not readily analyzeable by speakers into smaller units. This finding is consistent with the results of Read et al.[8] from a related dialect, in which ordinary subjects (i.e., subjects not familiar with the *pinyin* alphabetic transliteration scheme) proved unable to perform the simple task of replacing the initial consonant (onset) of a Mandarin word by another consonant; instead, their performance was eerily reminiscent of that found by Morais et al.[9] in a similar task with illiterate Portuguese speakers. (See [10,11] for further discussion of problems with the notion of the phoneme as a universal units of speech segmentation.) Future research will hopefully clarify which of these conclusions is the proper one to have made here.

### 2.3. Application to Korean

The Korean language is of much interest to this line of investigation, as there are reasons to believe that syllables in this language reflect a head + coda or 'left-branching' structure rather than the onset + rime or 'right-branching' organization of English (i.e., unlike English, vowel nuclei in Korean seem to adhere more closely to preceding consonants than to following

ones). Native speakers report this to be the case on the basis of their own intuitions, and Youn has recently conducted an informal word-blend production task, whose results were claimed to support this analysis (see [12]). A key aspect of this investigation, therefore, was to extend the forced-choice word-blending task to this language, in the hope of firming up these very intriguing preliminary suggestions.

### **2.3.1. Results from the Four-Choice Version**

A four-choice version of this task was first presented to Korean subjects in April of 1991, much in the way of a pilot investigation. Subjects were 82 undergraduate students registered in an English course at Sogang University in Seoul.<sup>9</sup> One Korean example from this test is illustrated here, with the two On + Ri choices underlined as in the previous examples: KANG + SEM -> (a) KAM (b) SENG (c) KEM (d) SANG. The full test contained 48 such items in all, with every attempt made to control for the problematic factors discussed in section 2.1.1. above. Answer sheets contained the four alternative blends for each input pair, randomly ordered and written out in standard Korean orthography so that subjects could circle their single, most preferred choice for each item. An overall analysis of On + Ri vs. He + Co choices throughout the test revealed an approximate 2:1 preference in favor of the latter, which was a highly significant result ( $p < .001$ ). This supported our preliminary expectations, as noted above, and was encouraging enough to have us proceed to a longer but better-controlled two-choice version of the test.

### **2.3.2. Results from the Two-Choice Version**

The two-choice version of the forced-choice word-blending task was carried out in Seoul in June of 1991. Two sample test items from this test are illustrated below:

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<sup>9</sup>Thanks are expressed here to Professor S.K. Cho, who not only offered the students in his class as experimental subjects, but who also assisted in the tabulation of their responses.



- 1(a). KANG + SEM -> KAM      2(a). SEM + KANG -> SANG  
 1(b). KANG + SEM -> KEM      2(b). SEM + KANG -> SENG

Subjects were 80 students registered in an undergraduate English class at Sogang University, all different from the ones tested previously.<sup>10</sup> As before, the results showed a clear preference in favor of He + Co blends, as illustrated by choices 1(a) and 2(b) above (as before, On + Ri choices are underlined for convenience). Interestingly, repeated measures ANOVAs revealed that this result was significant regardless of the order of presentation (choice "(a)" vs. choice "(b)") and for both real and nonsense blends. (Some differences emerged for real vs. nonsense words if the two blending types were of the 'no choice' variety, but this difference was significant only in the case where both choices were of the He + Co variety.)

Based on these data, the conclusion seems inescapable that Korean vowels are indeed more closely linked to preceding consonants than to succeeding ones, a result that is consistent with a left-branching model of the syllable. This is precisely the opposite result to that found for an onset-rime language like English and constitutes a direct challenge to the notion of a universal right-branching approach to syllable structure.

### 3. THE CROSS-LINGUISTIC EXPERIMENTAL ASSESSMENT OF SYLLABLE BOUNDARIES

As already noted in section 1. above, some practical difficulties were encountered in our attempts to extend to other languages the oral SI task that Treiman & Danis (T&D) used to assess syllable boundaries in English. Less than 10% of our Arabic subjects, for example, were able to perform any inversions at all, and when a similar problem emerged in the early stages of the Blackfoot investigation, it became clear that a new technique was going to have to be developed, one that would be simple enough for even illiterate subjects to

<sup>10</sup>We thank Professor K.C. Ja for kindly allowing us to use her class for twenty minutes to do this experiment.

perform.<sup>11</sup>

A new oral technique, called the 'pause-break' task, was thus developed on rough analogy with the written SI task. In this new task subjects are asked to choose which of two or three alternative 'breakings' of a word sound the 'most natural.' To illustrate for the English word MELON, for example, the following three alternatives were offered (where ... indicates the location of the pause): (a) /mɛ...lən/ (where /l/ is treated as the onset of the second syllable), (b) /mɛl...ən/ (where /l/ is the coda of the first syllable), or (c) /mɛl...lən/ (where /l/ is ambisyllabic). In an extensive pilot study, this task was presented to 95 undergraduate English students, all native speakers with little or no prior exposure to linguistics or phonetics. The main purpose of this study was to evaluate whether the earlier T&D results, using more difficult tasks, could be replicated, and, as shown in [5] and in even more detail in [13] (forthcoming), the answer was resoundingly in the affirmative. This new task has thus been adopted for testing or re-testing in most of the languages in the project, but at the time of this writing only the Korean and a very preliminary set of Arabic data are available for examination.

### 3.1. Syllable Boundaries in Korean

In the Korean writing system (called *hangul*), letters are used for individual segments and written from left to right, much as in English, but, by utilizing the vertical dimension, as well, these letters are also grouped into syllable-sized 'bundles.' The *hangul* spelling of each Korean word thus makes a commitment as to the location of a syllable-like boundary which every literate speaker presumably knows. The purpose of the

<sup>11</sup>This was especially critical for Blackfoot, as few speakers know the orthographic system that has been developed only recently by linguists for that language. Clearly, T&D's written slash-insertion task is completely inappropriate for use with such subjects.

present investigation, therefore, was to establish whether any general preference could be found that was independent of these orthographic norms.

In principle, we saw two possible ways to investigate this. One obvious course of action, obviously, would be to carry out the study among illiterate speakers, who would not know the orthographic norms. This effort is planned but has not yet been implemented, as the location of a suitable subject pool of this kind presents certain practical difficulties. The second approach, which could be implemented immediately using readily available university students, was to focus the investigation on homophones having a variable placement of the orthographic syllable boundary, depending on the morphological structure of the words involved.<sup>12</sup> The phonemic string MILI in standard Korean, for example, is ambiguously syllabified in the orthography as MI/LI (when it means 'in advance') or as MIL/I (when it means 'wheat + nom'), where a slash is used here to show the location of the break between the syllable-sized *hangul* 'packages.' For subjects who were given the meanings of the Korean words in the oral presentation used in our study, we expected a more-or-less slavish conformity to the orthographic norms. For the other group, however, who were not given the meanings, we were curious to see what alternative strategy might be used: to choose randomly, to choose the meaning most commonly used for each homophonic string and to follow the orthographic norm for that word, or, finally, to choose the location of the boundary on some general phonological basis, ignoring meaning.

The first round of Korean data was collected in October 1990 in Seoul, when two groups totaling 117 subjects were presented with six items similar to the one above, as well as a number of supplementary items selected to test cases mostly involving intervocalic tense consonants or consonant clusters. All subjects were undergraduate students in the Department of English at Sogang University, the great majority of whom grew up

<sup>12</sup>A third alternative, using nonsense words, is now also being explored.

in the general Seoul area. The results were as follows:<sup>13</sup> (1) The clearest cases involved single consonants that are restricted phonotactically to syllable-initial position, such as /C/ (as with SA-/CANG [1.00]), or to syllable-final position, such as /ŋ/ (as in PANG-/I [1.00]). (2) The results were also very clear for consonant clusters, where the preferred break occurs between them. This result was virtually unanimous if this break corresponded with the spelling (as in CHENG-/SO [.99] and KUK-/SU [.98]), but remained the majority view even when the orthography put the break after the second consonant (e.g., AN-C/A [.74] and KAP-S/I [.68]). (3) For tense consonants (written as geminates) the results were also fairly clear, with the preferred break once again after the vowel in spelling-supported cases (e.g., A-/PPA [.99] and KA-/CCA [.79]), but with a major shift to the spelling break if it occurred after the consonant (e.g., MU-KK/E [.45] and KA-SS/E [.32]). (4) In the crucial orthographically ambiguous strings, which mostly involved single intervocalic consonants, the preferred break position was immediately after the vowel; however, as shown in the summary of these results below, the size of the plurality varied considerably, apparently depending on the type of consonant involved (see [5] for some other, related observations).<sup>14</sup> Note also that two figures are given for these words, the first showing the proportion of subjects who broke the words at the hyphen under the 'no meaning' or 'ambiguous string' condition, and the second showing the profound effect of disambiguation, when the meanings were all

<sup>13</sup>In all of these examples, a hyphen is used to show the judged syllable break and a slash (/) to show where the break occurs in the spelling; if both breaks coincide, the composite symbol -/ is used. The numbers indicate the proportion of subjects who chose to break the words at the place marked by the hyphen.

<sup>14</sup>Further work is now in progress to establish whether this is a true sonority effect or a mere artifact of word/spelling frequency.

supplied.

MI-/LI	(.91/.95)	vs.	MI-L/I	(.91/.27)
A-/NI	(.83/1.00)	vs.	A-N/I	(.81/.20)
I-/PYENG	(.66/.97)	vs.	I-P/YENG	(.45/.25)
CE-/KE	(.55/.95)	vs.	CE-K/E	(.55/.63)
SO-/KA	(.53/.97)	vs.	SO-K/A	(.52/.25)
IMO-/KI	(.60/1.00)	vs.	IMO-K/I	(not tested)

If the post-vocalic break position was unambiguously supported by the spelling for such consonants, the effect was, of course, maintained and even enhanced (e.g., I-/MOKI [.89/.94]), but if an unambiguous (or heavily frequency-biased) spelling break was located after the consonant, a major shift again occurred in that direction (as in KI-L/I [.48/.54]). (Notice that supplying the meaning had little effect for these two words, which was the general trend for the non-ambiguous items throughout.)

From these results we can tentatively conclude that the preferred phonological breaking point for Korean syllables, uninfluenced by the spelling, occurs between two consonants in a CC cluster, but before a single intervocalic consonant.

### 3.2. Syllable Boundaries for Arabic

In July of 1991 a pilot study was run in Cairo, Egypt, to test the suitability of the 'pause-break' technique for Arabic. While only 13 subjects were able to be tested under the circumstances in force at that time, a complete test of 30 items was used, which included items of three different types: (1) bisyllabic words with intervocalic CC clusters (such as 'AKBAR), (2) bisyllabic words with single intervocalic consonants (e.g., LIBAD) and (3) bisyllabic words containing intervocalic long or 'geminate' consonants. The results showed a strong preference (69%) to break between the two consonants of clusters, as well as to break before a single intervocalic consonant (70%), just as in the Korean case. Judgments were split on the geminates, however, as one popular strategy (40%) was to choose the

break position before them, thus treating them in the same way as single consonants, while another popular approach (43%) was to choose the ambisyllabic response, thus treating them in the same way as the CC clusters. In any event, the technique has apparently proved its mettle once again and large-scale testing will begin in September, the results of which should be available for presentation at the conference itself.

#### 4. CONCLUSIONS

Our attempt to expand the experimental exploration of syllable structure to languages beyond English has been slowed by the fact that new experimental techniques have had to be developed in nearly all cases. Nevertheless, the following preliminary results can now be reported: (1) Korean syllables appear to be of the left-branching or head+coda type, challenging the universality of the onset+rime strategy; (2) the tiny syllables of the Chinese dialects (in this case Taiwanese) continue to resist experimental attempts at sub-analysis, casting further doubt on the universality of the phoneme as a basic unit (cf. [11]); and (3) Korean speakers show a decided preference to divide V-/C/V and VC-/C/V sequences at the positions marked by hyphens, even though their orthography permits syllable-like breaks at all four of the positions marked by slashes. Finally, (4) a very small sampling of Arabic subjects shows a highly similar syllabification strategy for that language, as well, though complicated by the problem of the geminates, which seem to be treated rather ambiguously as either single long or as doubled consonants.

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