SIMPLE SYLLABLE STRUCTURE
AND ENGLISH PRE-NUCLEUS GLIDES

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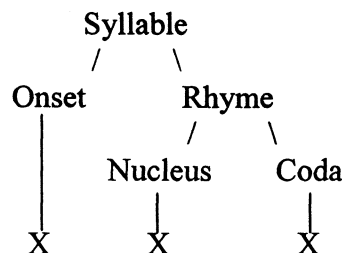University of Michigan, Ann Arbor, U.S.A.
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The purpose of this paper is to test whether the Simple Syllable Structure (SSS) proposed by Duanmu (1990:[2]) is true of English onsets or not. If the SSS holds for English onset, English onglides should be secondary articulations on the onset consonant rather than separate sounds. We will test this by measuring the duration of the initial consonant –glide combination, to determine whether it is as long as two sounds or as one sound. If the consonant – glide combination is as short as one consonant, we can say that glides are secondary articulations supporting a simpler syllable structure hypothesis (Duanmu 1990:[2], Kim 1997:[6]) for English onsets.

1. THORETICAL BACKGROUND

1.1 Simple Syllable Structure

The Simple Syllable Structure (SSS) was proposed for Chinese by Duanmu (1990: [2]) and adopted for Korean by Kim (1997: [6]). As shown in (1), in the SSS maximally three positions are allowed: one for the onset, one for the nucleus, and one for the coda.

(1) Simple Syllable Structure

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                Syllable
                /      \
        Onset         Rhyme
          |           /    \
          |      Nucleus    Coda
          |         |         |
          X         X         X
```

As the first step to test whether this SSS is true of English onsets, I measured the consonant- glide combinations (CG) in the onsets. To see why CG's are chosen, we need to look at the assumption by Feature Geometry on which the SSS depends.

1.2 Feature Geometry

According to Feature Geometry (FG), each articulator can only occur once in a single sound and thus non-homorganic clusters can be represented as one sound while homorganic ones cannot. For example, [t] and [w] can be represented with one feature tree because they are articulated by

two different articulators, namely, Coronal and Labial while [t] and [j] cannot because both of them are articulated by a same articulator Coronal. However, it should be noted that FG does not say the non-homorganic sounds have to form one sound but says that they can form one sound. Feature trees for homorganic and non-homorganic clusters are given in (2).

(2) Feature Tree

	a.	X			b.	X	X
		/ \				| |
		Place$_i$ Place$_j$				Place$_i$ Place$_i$
		| |				| |
		C C				C C
		[t] [w]				[t] [j]
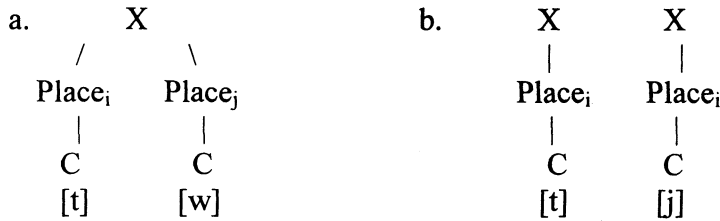
In (2a), to say that [t] and [w] form a sound means that [t] and [w] are pronounced at the same time with [w] as a secondary articulation imposed on [t]. The reason for [w] being the secondary articulation is that a secondary articulation is more vowel-like and a primary articulation is more consonant-like[1].

1.3 Issue

About the duration of a secondary articulation, Ladefoged and Maddieson (1996: [4]) note that the total duration of the gestures in secondary articulations does not equal that of a sequence of two corresponding articulations in a cluster. The proposed reason for this is that in the case of secondary articulations, the two gestures occur largely simultaneously, even though there is a small timing offset between the articulations. However, I am not aware of any study of durational measuring of consonant clusters in English except Klatt (1978). However, his study does not include consonant + the glide /j/ and does not compare the duration of consonant clusters (CC) and single complex consonants with a secondary articulation (C^C).

2. ENGLISH ONSET

Most English onset clusters are non-homorganic CC's as is seen in (3). In (3), '+' indicates a possible combination and '–' indicates an impossible combination.

(3) American English Onsets: two consonants (Kenstwicz 1994: [5])[2]

C$_1$\ C$_2$	w	j	r	l	m	n	p	t	k
p	-	+	+	+	-	-	-	-	-
t	+	-	+	-	-	-	-	-	-
k	+	+	+	+	-	-	-	-	-
b	-	+	+	+	-	-	-	-	-
d	+	-	+	-	-	-	-	-	-

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[1] For more details, see Ladefoged and Maddieson (1996: [4]).
[2] In British English [tj] is permitted as in *tune*.

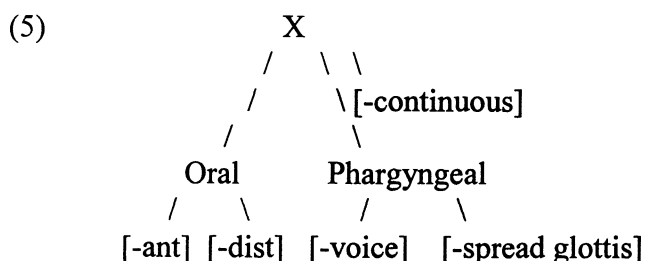									
g	+	+	+	+	-	-	-	-	-
f	-	+	+	+	-	-	-	-	-
θ	+	-	+	-	-	-	-	-	-
ʃ	-	-	+	-	-	-	-	-	-
s	+	-	-	+	+	+	+	+	+

All CG's and most onset CC's in English have two different articulators and thus can have a representation of (2a). The exceptions to (2a) are in (4). CC's in (4) cannot be represented by one feature tree but should have two trees as in (2b).

(4) homorganic CC
    alveolar + /r/ : θr, ʃr
    /s/ + C   : sl, sn

Even though /tr, dr/ are articulated by the same articulator, Coronal, they are fine to form one sound because these are considered as retroflexed affricates in Feature Geometry. Feature geometric representation for the retroflex sound /tr/ is in (5). To get retroflex sound the only thing to be added is [-ant] to the representation of [t].

(5)
```
                    X
                  /  \  \
                 /     \ [-continuous]
                /       \
            Oral      Phargyngeal
            /  \        /   \
      [-ant] [-dist] [-voice]  [-spread glottis]
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3. EXPERIMENT

3.1 Design

To see if a pre-nucleus glide is a secondary articulation on the primary consonant of the onset or not, a small-scaled acoustic analysis was performed. For the experiment I chose CG's among other onset CC's because all CG's are non-homorganic and thus can be represented with one feature tree. This study would be the first step to test whether the SSS is true of English onset or not, at least of CG's.

    The experiment contains a set of comparisons. In each set we measure the duration of the onset of one syllable[3] words where the onset is a consonant + glide, a consonant alone, or a glide alone: **CG** in # CGV(C), **C** in # CV(C), and **G** in # GV(C). To take an example, the durations of /tw/ in a word *twin*, /t/ in *tin*, and /w/ in *win* are measured. If the glide is a secondary articulation, the duration of the CG's should be shorter than the sum of the duration of C and G when they appear separately, approximating the duration of one consonant. The duration of CG is

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[3] There are two disyllabic words in the word list because I could not find appropriate monosyllabic words. They are *dwindle*, and *beauty*.

expected to be closer to that of the longer consonant of the two consonants involved or a half of the durational sum of the two consonants. In (6) a capital letter D stands for duration.

(6) Hypothesis
    a. if D(tw) = ½ (D(t) + D(w)) or longer C of the two C's ,
        then *tw* is one sound, supporting the SSS
    b. if D(tw) = D(t) + D(w),
        then *tw* is two sounds, not supporting the SSS

The word list is given in Appendix 1. A list of the words was constructed to include 18 words.

3.2 METHOD

The list was randomized and recorded in a sound proof room at a moderate rate with five repetitions by two male speakers. All words were spoken in the carrier sentence "Say X again" in order to produce speaking rates closer to conversational speech and to avoid effects of pre-pausal lengthening in utterance-final position. I included both aspiration and closure into the duration of stops, which is shown spectrograms in (7).
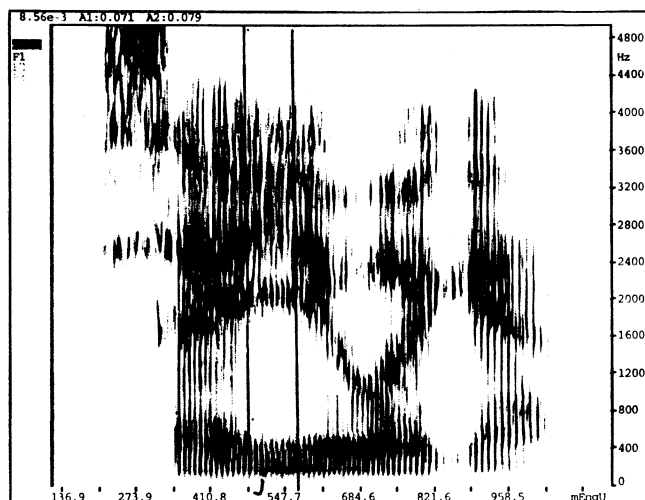
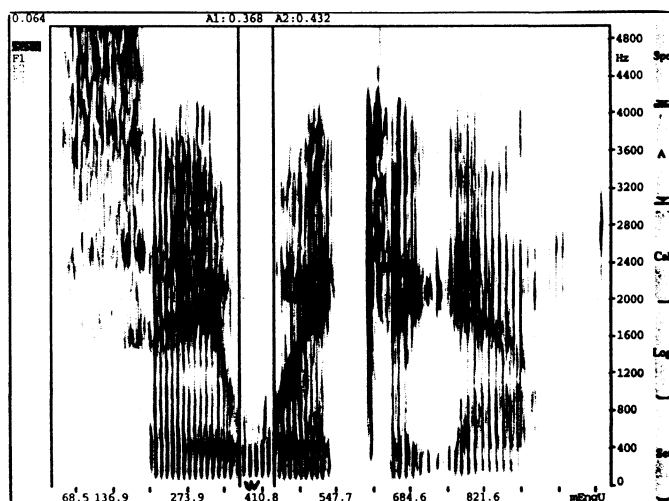(7) a. Spectrogram of [b]
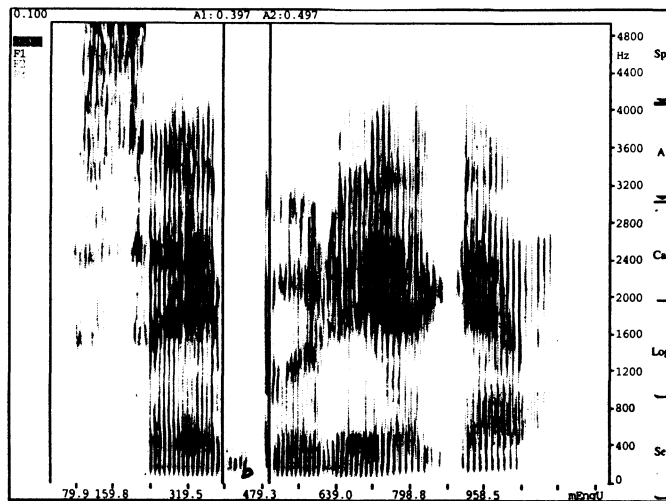
b. Spectrogram of [k]
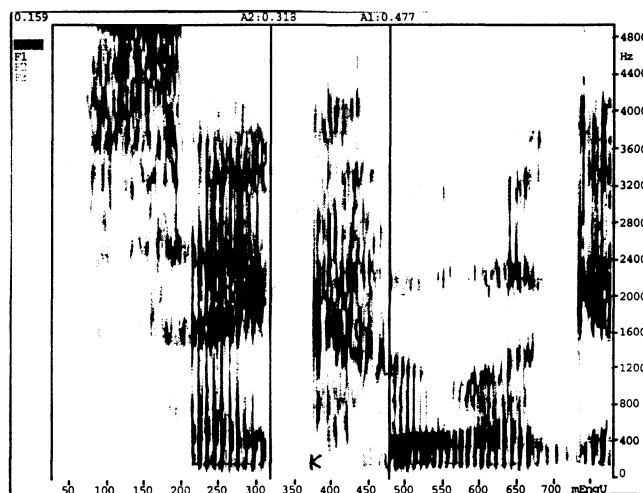
Onset and offset point of glides are defined in combination of the spectrogram and waveform displays. As we can see in (8), glides has overall low amplitude and weak formant structure. I excluded the transition period of glides.

(8) a. Spectrogram of [j]

b. Spectrogram of [w]

4. RESULT

The average durations are given in table 1.

	D(C)	D(G)	D(CG)	D(C) + D(G)
t, w, tw	146.3	67.4	172.1	213.7
d, w, dw	117.3	67.4	129.8	184.7
k, w, kw	149.7	64.8	152.2	214.5
p, j, pj	149.7	49.9	190.8	199.6
b, j, bj	99.8	52.3	147.2	152.1
k, j, kj	157.2	52.3	201.3	209.5
average	136.7	59.0	165.6	195.7

TABLE 1 : duration of CG's (ms.)

Ideally the average value of column 4 should be half of that of column 5 if C^G is really one sound. In other words, we expected the average duration of C^G to be close to 97.9 or 136.7 but it is 165.6. This suggests that the average duration of the consonant – glide combination is much longer than that of a single consonant (97.9 or 136.7) although it is shorter than that of two consonants in succession (195.7).

(9) Expected Length of CG
   CG = ½ (C +G) or a longer C = 97.9 or 136.7 (ms.)

One interesting thing is that the glide /j/ behaves differently from the glide /w/. The different behavior is clear in tables 2 below. The duration of Cj is closer to two segments while Cw is not that close.

	Cj	C + j	(C+j) – Cj
Duration (ms.)	179.8	187.1	7.3
	Cw	C + w	(C+w) –Cw
Duration (ms.)	151.4	204.3	52.9

TABLE 2: comparison of Cj and Cw

The consonant- /j/ combination is as long as the sum duration of two consonants, but the consonant-/w/ is shorter than the sum duration of two consonants.

This different behavior of /j/ and /w/ is not supportive of Feature Geometry and the Simple Syllable Structure hypothesis. It is of interest to note that Davis and Hammond (1995: [1]) argue that /w/ in a CwV sequence is in the onset while /j/ in a CjV sequence is in the nucleus based on some phonological phenomena such as phonotactics, Pig Latin, a name game, and [j] insertion[4]. Interestingly enough, our finding is supportive of their claim. In addition, Duanmu (1997: [3]) claims that the English diphthong /ju/ is a long diphthong rather than short one. This finding is also very supportive of Duanmu's claim.

Finally, I converted the absolute value to the relative value, setting the sum duration of two consonants as 2. This is to see how the length of C^j and C^w compared with C+ j and C + w. The converted values are given in table 3.

	Converted duration	Duration of C + C
C^w	1.48 (<- 151.4)	2 (<- 204.3)
C^j	1.92 (<- 179.8)	2 (<- 187.1)

TABLE 3: Converted Length

The values in table 3 are visualized in the following graph. The point 2 indicates the sum duration of two independent consonants.

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[4] At the Mid-Continental Workshop on Phonology, Davis S. pointed out that in his theory *t* and *w* in *twin* have two separate positions in the onset. He also pointed out the fact that *nw* is not allowed in English even though they do not share the same articulator.

Length of CG

converted length

CG
C+C

Cw   Cj
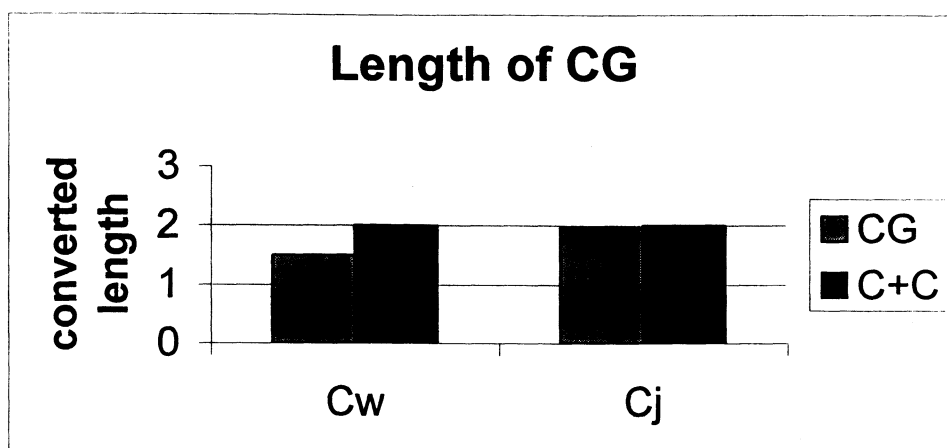
5.CONCLUSION

Judging from the analysis above, first, the duration of C^G is a little bit shorter than the sum of two consonants in isolation but much longer than one consonant. Second, C^w and C^j behave differently: the former is much shorter than two consonants and the latter is as long as two consonants. This finding does not seem to support Feature Geometry and the SSS hypothesis. The reason is that Feature Geometry and the SSS expect C^w and C^j to behave in the same way, and under the SSS both C^w and C^j are predicted to be as long as one segment.

6. FURTHER STUDY

The experiment is a small scale pilot study. There are three things, in particular, I would like to explore for further study. First, we need study including more tokens, more speakers, and statistical analysis. Second, the duration of whole words and vowels would be measured. If a glide is really an independent sound, then the duration of the whole word with a glide would be longer than words with one onset consonant, and vowel length of the words with CG and the words with one C should be the same. (10b) is the case when we can say a glide is an independent sound rather than a secondary articulation. If the case turns out to be (10c), then we need more careful interpretation about the result.

(10)
a. ———C———▶———V———▶
b. ———C———▶———G———▶———V———▶
c. ——C—▶—G—▶—V—▶
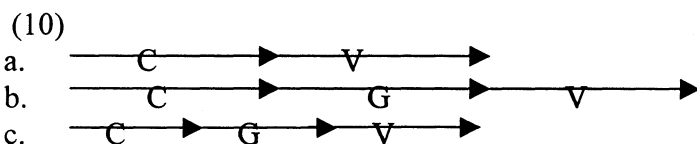
For example, the duration of *win* or *tin* should three-fourths as long as *twin* if /w/ is not a secondary articulation. If the whole word with a glide is as long as the word without a glide, then we would not say that a glide is a separate sound, even though the duration of a combination of a consonant and a glide is longer than one sound. Third, further study would involve homorganic onset CC's, coda CC's, and non-homorganic coda CC's in English. In addition, a comparative study of the durational difference between C^j and C^w in Korean would be of interest because in Korean both /j/ and /w/ are argued to be in the same position of the syllable structure unlike English /j/ and /w/.

WORD LIST

tin, win, twin
din, win, dwindle
kick, wick, quick
poor, your, pure,
booty, you, beauty
coo, you, cue

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