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Fundamental Generalizations of English Syllabification

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Since the early 1970s, researchers have recognized the syllable as a fundamental unit of phonology. Despite this, no consensus has emerged as to how a phonetic string is segmented into syllables, i.e. syllabification. This paper reviews the theoretical and empirical literature to provide an understanding of the nature and location of syllable boundaries, in order to help us understand what role syllables play in processing speech and written text—an especially crucial consideration for ESL/EFL learners with native languages whose syllable structures are simpler than that of English.

Keywords: syllables, syllable structure, written syllabification, spoken syllabification

1. Introduction

Since the early 1970s, researchers (e.g. Pulgram 1970, Hooper 1972, Kahn 1976) have recognized the syllable as a fundamental unit of phonology, an awareness that has only increased with the emergence of nonlinear phonology (e.g. Liberman 1975, Liberman and Prince 1977), prosodic phonology (e.g. Selkirk 1978, Nespor and Vogel 1986), and Optimality Theory (e.g. Prince and Smolensky 1993, McCarthy and Prince 1993). Other studies show syllables to be crucial to phonological awareness, reading, and spelling (e.g. Liberman et al. 1974, Treiman and Danis 1988a, Snow et al. 1998, Treiman et al. 2002). Treiman and colleagues (Treiman and Danis 1988b, Treiman 1989, Fowler et al. 1993, Treiman et al. 1995) have explored the role of syllables in the internal structure of words. Some phonotactic facts become explainable on the assumption that syllables have internal structure. Stress, tone, and other suprasegmental phenomena likewise relate to syllables, according to many scholars (see Blevins 1995). There is psycholinguistic evidence that the syllable serves as a functional unit in speech production (e.g. Levelt and Wheeldon 1994, Schiller et al. 1996, Ferrand et al. 1997, Levelt et al. 1999, Cholin et al. 2004, Cholin et al. 2006).

Despite burgeoning scholarly interest in the syllable and its role in phonology, no consensus has emerged as to the generalizations or rules for how a phonetic string is segmented into syllables, i.e. syllabification. By reviewing recent empirical psycholinguistic evidence and relevant phonological theories, this paper proposes some fundamental generalizations about English syllabification. An understanding of the nature and location of syllable boundaries should help us understand what role syllables play in processing speech and written text—an especially crucial consideration for ESL/EFL learners with native languages whose syllable structures are simpler than that of English.

2. The syllable-related difficulties that EFL learners in Taiwan may face

The syllable-related difficulties that EFL learners in Taiwan may face are shown as follows:

(1) Complex syllable structure. The traditional components of the syllable are the onset and the rhyme. The rhyme is further divided into the nucleus (vowel) and the coda. Thus, the onset, the nucleus, and the coda are three main elements of a syllable. Languages differ considerably in the syllable structures that they permit. Hawaiian allows no more than one consonant in an onset, and none in the coda, so that every word (e.g. Honolulu and Waikiki) ends in a vowel (Ladefoged 2006). English has complex onsets and codas, having at most three consonants before the vowel and four consonants after the vowel (Abercrombie 1967), viz.: (C)(C)(C) V (C)(C)(C)(C).

Accordingly, English has 19 possible syllable types or shapes, as illustrated by Sun (2007:106) in Table 1. Based on the number of consonants that may surround the vowel nucleus, the syllable types may be grouped into two categories: simple and complex. Simple syllables refer to the first 4 types that have only single consonants in the onset or/and the coda. The other 15 types are complex syllables, having consonant clusters in the onset or/and the coda.

Mandarin Chinese, by contrast, allows a maximum of four phonemes, (C)(G)V(X), in a syllable (Duanmu 2006). In this notational system, C is a consonant, G is either a glide or the first part of a diphthong or a triphthong, V is a vowel, and X is either a nasal consonant (n [n] or ng [ŋ]) or the last part of a diphthong or a triphthong. CG is not a consonant cluster in CGV and CGVX, where G is the first part of a diphthong or a triphthong. Thus, Mandarin Chinese allows only simple syllables, none of which begins or ends with a consonant cluster. Table 2 shows 8 types of Mandarin Chinese syllables.

The combination of two or more consonants is permitted by English phonotactic rules, but not in Chinese. In English there are 15 types of complex syllables, which are made up of sequences of two or more consonants before, after, or around the vowel. A peculiar feature of English is the phonotactic rules that govern what consonants can be combined into a cluster, and in what order. For example, both English and Chinese have the individual phonemes /s/, /p/, /r/, and /e/. In English these phonemes can be combined into the syllable /spre/ (*spray*), but such a sequence is not permitted in Chinese. The pronunciation of consonant clusters is usually a severe problem for EFL learners in Taiwan.

Table 1. Types of English syllables[1]

	Syllable Type	Word Example	
Simple Syllables			
(1)	V	I	/aɪ/
(2)	CV	go	/go/
(3)	VC	it	/ɪt/
(4)	CVC	sit	/sɪt/
Complex Syllables			
(5)	CCV	free	/fri/
(6)	VCC	ox	/ɑks/
(7)	CCCV	spray	/spre/
(8)	VCCC	asked	/æskt/
(9)	CVCC	cooked	/kʊkt/
(10)	CVCCC	depths	/dɛpθs/
(11)	CVCCCC	sixths	/sɪkθs/
(12)	CCVC	stood	/stʊd/
(13)	CCCVC	strike	/straɪk/
(14)	CCVCC	treats	/trits/
(15)	CCVCCC	trusts	/trʌsts/
(16)	CCVCCCC	twelfths	/twɛlfθs/
(17)	CCCVCC	strikes	/straɪks/
(18)	CCCVCCC	strengths	/strɛŋθs/
(19)	CCCVCCCC	strengths	/strɛŋkθs/

*Note: the word *strengths* pronounced as /strɛŋkθs/ is a dialectal variation in which /k/ is inserted.

Table 2. Types of Mandarin Chinese syllables[2]

Syllable		Example
(1)	V	阿 ㄚ a
(2)	CV	八 ㄅㄚ ba
(3)	GV	窩 ㄨㄛ wo
(4)	CGV	拖 ㄊㄨㄛ tuo
(5)	VX	凹 ㄠ ao，安 ㄢ an
(6)	CVX	貓 ㄇㄠ mao，般 ㄅㄢ ban
(7)	GVX	邀 ㄧㄠ yao，央 ㄧㄤ yang
(8)	CGVX	喵 ㄇㄧㄠ miao，香 ㄒㄧㄤ xiang

[1] Adopted from Sun (2007:106).
[2] Created by the author of the present study according to the notational system of Duanmu (2006).

(2) Polysyllabic words. Syllabification is particularly important in the case of Mandarin Chinese, where a one-to-one correspondence exists between a character (the primary written unit), the syllable (the basic pronunciation unit), and the lexical morpheme (the basic meaning unit) (e.g. Ho and Bryant 1997, McBride-Chang and Ho 2000). Garmon (1990) points out that the phonological aspects tend to be related to characters/syllables, rather than to segments. Reading Chinese generally sensitizes the readers to syllables, represented as characters, in much the same way that reading an alphabetic language sensitizes readers to phonemic segments, represented as letters (e.g. Wagner et al. 1994, Chow et al. 2005). Therefore, the Chinese writing system is composed of characters, and the fact that one character corresponds to one syllable makes Chinese a monosyllabic language. By contrast, there are many polysyllabic words in English. For EFL learners in Taiwan, syllabifying English polysyllabic words into several individual syllables makes it much easier to process and recall those long English words (e.g. Lin and Wu 2006, Lin 2010a, 2010b).

(3) Variable and mobile stress. The term "stress" encompasses the prosodic features of duration, intensity, and pitch. Stressed syllables are generally longer, louder, and higher in pitch than unstressed syllables. English has variable stress, meaning that in a polysyllabic word, any syllable might receive stress. The three-syllable words *algebra* [ˈældʒəbrə], *zucchini* [zʊˈkɪnɪ], and *kangaroo* [ˌkæŋgəˈru] receive stress on the first, second, and third syllables, respectively. In addition to variability, English stress is said to be mobile, as illustrated by the stress-shifts in morphologically-related words such as *origin* [ˈɔrədʒɪn], *original* [ɔˈrɪdʒənl̩], *originality* [ɔˌrɪdʒəˈnælətɪ].

Stress is a suprasegmental feature of utterances. It applies not to individual vowels and consonants but to whole syllables (Ladefoged 2006). Misunderstandings often result from mistakes in stress, whose placement must be learned along with the vocabulary itself. Syllabification can help EFL learners in Taiwan understand exactly where a stressed/unstressed syllable starts and ends.

Various studies have established that ESL/EFL learners encounter difficulties with English syllable structure, especially when the syllable structure of their native language is relatively simple, as in the case of Chinese (e.g. Eckman 1981, 1991, Anderson 1983). A practical consequence is the difficulty of transliterating words from languages with more complex syllable structures, which many ESL/EFL learners may encounter.

3. Spoken syllabification vs. written syllabification

Ordinary dictionaries consider syllabification from the point of view of orthography, i.e. rules for word-division in writing or in print, with raised dots

customarily used to indicate suitable breaks: *sit·ting*. However, the word *sitting* does not really have two phonetic [t]'s—English speakers do not really say [sɪt-tɪŋ], but something closer to [sɪ-ɾɪŋ] (Bauman-Waengler 2009). This underscores the difference between written and spoken syllabification. A common problem in writing is deciding where to break a word with a hyphen (i.e. end-of-line divisions),[3] in order for the right margin to appear more-or-less even. For example, the word *or·thog·ra·phy* may end on one line with:

or-
orthog-
orthogra-

and continue onto the next line with:

thography
raphy
phy

Today, computer word-processing programs are capable of justifying the right margin automatically, for example by adjusting the spacing of the text. The problem of hyphenation (written syllabification) in writing or in print has therefore become something of a non-issue. Nevertheless, the issue of spoken syllabification is quite distinct from that of written syllabification.

It is obvious that written and spoken syllabification use different principles. Written syllabification seems to follow the two principles described by Yavaş (2006). The first principle follows morphology: written syllabification maintains the integrity of prefixes/suffixes. This often results in conflict between written and spoken syllabifications. For example, *teach·er* and *sav·ing* represent the written breaks, for which the spoken equivalents would be [ˈɾi-tʃɚ] and [ˈse-vɪŋ]. The second principle of written syllabification distinguishes between the ability of long and short vowels to function within the context of an open or closed syllable (e.g. Pulgram 1970, Small 2005). In the case of one-syllable words, long vowels can only appear in open syllables (*see*, *toe*, *new*), while short vowels can only appear in closed syllables (*hit*, *pet*, *put*). However, with polysyllabic words, spoken English sometimes ends open syllables with stressed short vowels (Treiman and Zukowski 1990). For example, in the pair *coma—comma*, the letter *o* in the first word *coma* stands for the long vowel

[3] The term "end-of-line division" is used as "written syllabification" in the *Merriam-Webster's Collegiate Dictionary* (11th Edition).

[o], yielding the written syllabification *co·ma* and the spoken syllabification [ˈko-mə]; the letter *o* in the second word *comma* stands for the short vowel [ɑ], leading to the written syllabification *com·ma*, which differs from the spoken syllabification [ˈkɑ-mə]. Thus, these two principles lead to wide discrepancies between written and spoken syllabification. There are obvious discrepancies between the breaks in the written language and the syllable breaks in the spoken language for the following words:

Written syllabification	Spoken syllabification[4]
teach·ing	[ˈti-tʃɪŋ][5]
of·fend·er	[ə-ˈfɛn-dɚ]
hap·pen	[ˈhæ-pən]
bor·row	[ˈbɑ-ro]
the·ater	[ˈθi-ə-tɚ]
of·ten	[ˈɔ-fn̩]
prism	[ˈprɪ-zəm]
ex·qui·site	[ɪk-ˈskwɪ-zɪt]

The following seven conditions account for most cases of disagreement between written syllabification and spoken syllabification:

(1) Where written syllabification gives priority to retaining the integrity of both prefixes and suffixes, spoken syllabification follows the principle of pronunciation. For example, in *exasperate*, *ex-* is the prefix, *-ate* is the suffix, and *-asper-* is the root, so that the word is divided *ex·as·per·ate* writtenally, but [ɛg-ˈzæs-pə-ˌret] phonetically. The written syllabification for *offender* is *of·fend·er*, but its spoken syllabification is [ə-ˈfɛn-dɚ].

(2) In words like *common*, *happen*, *butter*, the written language divides intervocalic doubled letters. In spoken syllabification, by contrast, the single phoneme is always parsed to the second syllable: *com·mon* [ˈkɑ-mən], *hap·pen* [ˈhæ-pən], *but·ter* [ˈbʌ-tɚ].

(3) Both the written and spoken language divide words like *soldier*, *obtain*, *athlete* between the two different intervocalic letters, since these represent two different phonemes: *sol·dier* [ˈsol-dʒɚ], *ob·tain* [əb-ˈten], *ath·lete* [ˈæθ-lit]. However, in words with silent letters like *often* or *shepherd*, the two intervocalic graphemes are divided, while the sole phoneme always belongs to the second syllable: *of·ten* [ˈɔ-fn̩], *shep·herd* [ˈʃɛ-pɝd].

[4] For both the spoken and written syllabifications in this paper, please refer to the *Merriam-Webster's Collegiate Dictionary* (11th Edition), which is one of the most well-known English pronunciation dictionaries.

[5] For the phonetic transcriptions of the words in this paper, please refer to the Kenyon and Knott (K.K.) system shown in the *Oxford Advanced Learner's English-Chinese Dictionary* (6th Edition).

(4) Written and spoken syllabification may have different numbers of syllables: *the·ater* [ˈθi-ə-tɚ] (2:3), *choc·o·late* [ˈtʃɑ-klət] (3:2), *veg·e·ta·ble* [ˈvɛdʒ-tə-bl̩] (4:3), *his·to·ry* [ˈhɪs-trɪ] (3:2).

(5) The two letters *sm* cannot form a single syllable in the written language, but they usually form one syllable in the spoken language: *prism* [ˈprɪ-zəm], *chasm* [ˈkæ-zəm], *op·ti·mism* [ˈɑp-tə-ˌmɪ-zəm].

(6) The letter *x* is pronounced [ks] or [gz]. When the two phonemes are intervocalic, they are divided into different syllables: *taxi* [ˈtæk-sɪ], *exit* [ˈɛg-zɪt].

(7) Spoken syllabification, unlike written syllabification, incorporates legal clusters into the onset of the following syllable, such as *ex·qui·site* [ɪk-ˈskwɪ-zɪt], *prog·ress* [ˈprɑ-grəs], *par·tic·u·lar* [pɚ-ˈtɪ-kjə-lɚ], *prob·lem* [ˈprɑ-bləm].

The difference between written syllabification and spoken syllabification is an important issue in English because not only phonotactic constraints but also phonological and stress rules are sensitive to syllable structures, and these are entirely based on spoken syllables, and have nothing to do with the conventions of written breaks.

Unfortunately, written syllabifications are not simply suggestions for where to place breaks in the written language, but are also relied upon for phonetic transcriptions in dictionaries such as *the Cambridge International Dictionary of English* (1995), *the Encarta World English Dictionary* (1999), *the Random House Compact Unabridged Dictionary* (1996), *the American Heritage Dictionary of the English Language* (1985), and *Webster's New World Dictionary of American English* (1994) and in popular vocabulary-building books like *Vocabulary in Use Intermediate* (Redman and Shaw 1999) and *Vocabulary in Use Upper Intermediate* (McCarthy et al. 2001). Among quite a few English pronunciation books such as *Pronouncing American English* (Orion 1997), *Targeting Pronunciation: The Intonation, Sounds, and Rhythm of American English* (Miller 2005), *Teaching English Pronunciation* (Kenworthy 1987), *Well Said: Advanced English Pronunciation* (Grant 2000), and others, the principles of written syllabification instead of spoken syllabification are used to analyze the spoken syllables. Furthermore, the written syllabification system is taught to elementary schoolchildren in the United States (Yavaş 2006). Hence, the difference between written breaks and spoken syllables needs to be made very clear. It is in spoken English that the syllable plays an important role.

4. Empirical evidence for syllabic units in speech production

In the speech production model proposed by Levelt, Roelofs, and Meyer (1999), syllables play a crucial role at the interface of phonological and phonetic encoding.

The evidence gained from their study supports the general hypothesis that the syllable constitutes a real unit of speech production in English. Altogether, the results obtained in English by Ferrand, Segui, and Humphreys (1997), in French by Ferrand, Segui, and Grainger (1996), and in Dutch by Levelt and Wheeldon (1994) and Wheeldon and Levelt (1995) strongly suggest that the syllable is indeed a basic unit of speech production across languages. In fluent speech, the individual sounds of a word are bundled together to form optimally pronounceable units, namely syllables, which serve as the basis for motor execution (e.g. Levelt and Wheeldon 1994, Roelofs 1997a,b, 1999, 2002, Levelt et al. 1999, Cholin et al. 2006). The composition of syllables follows both universal syllabification constraints (such as maximization of onsets and sonority gradations) and language-specific phonotactics (such as legality and stress principle), and these rules work together to create easily-pronounceable syllables.

5. Allophonic variations related to spoken syllabification

Rules about the allophonic variations, regarding aspiration, devoicing, velarization, distribution of some sounds, etc., show how syllabification influences the sound patterns in utterance:

(1) Voiceless stops (i.e. /p, t, k/) are aspirated at the beginning of syllables, as in words *pip* [pʰɪp], *test* [tʰɛst], *kick* [kʰɪk], etc. That this characteristic is not restricted to the word-initial position can be verified in words *apart* [əˈpʰɑrt], *attack* [əˈtʰæk], *occur* [əˈkʰɝ], etc., where the aspirated stops are not word-initial but syllable-initial.

(2) Voiceless stops /p, t, k/ are unaspirated after a tautosyllabic /s/ in words *misspell* [mɪsˈspˉɛl], *disturb* [dɪˈstˉɝb], *discuss* [dɪˈskˉʌs], etc. These voiceless stops are unaspirated in that all of them are followed by a tautosyllabic /s/. In fact, voiceless stops /p, t, k/ are more like the so-called voiced stops /b, d, g/ when they are completely unaspirated. (Note that voiceless stops /p, t, k/ are still aspirated after a heterosyllabic /s/ in words *displace* [dɪsˈpʰles], *distrust* [dɪsˈtʰrʌst], *discount* [dɪsˈkʰaʊnt], etc.)

(3) In syllable-final position, stops /p, b, t, d, k, g/ may be unreleased; that is, the stop closure may not be broken to let air flow out. The /p/ becomes [pˀ] in *top* [tɑpˀ], the /b/ becomes [bˀ] in *cub* [kʌbˀ], and the /k/ becomes [kˀ] in *cook* [kʊkˀ]. In *temptation* [tɛmpˀˈtʰeʃən], the /p/ becomes unreleased [pˀ] in that it is in the syllable-final position, and /t/ becomes aspirated [tʰ] in that it is in the syllable-initial position. It is interesting to note that some children who delete syllable-final consonants in the word-final position retain them when morphological processes position them in the word-medial intervocalic position. For example, a child who omits the final consonants in words

hop [hɑp], *dog* [dɔg], *pig* [pɪg], and *bake* [bek] may produce those same consonants in words *hopping* [ˈhɑ-pɪŋ], *doggie* [ˈdɔ-gɪ], *piggie* [ˈpɪ-gɪ], and *baker* [ˈbe-kɚ], respectively (Weismer et al. 1981). In the latter series of words, the consonants are resyllabified from final to initial position.

(4) Voiced obstruents (i.e. /b, d, g, v, ð, z, ʒ/) are voiced through only a small part of the articulation when they occur in the syllable-final position. For example, the voicing of the /z/ in *lose* [luz̥] is not fully voiced. However, the /z/ in *loser* [ˈlu-zɚ] is fully voiced since it is syllabified as the onset of the second syllable. In *prove two times two is four* or *try to improve*, where the /v/ is in the syllable-final position, it is not fully voiced. However, in a phrase such as *prove it* [pru-vɪt], the /v/ is fully voiced because it is followed by a vowel and then resyllabified as the onset of the following syllable.

(5) The lateral /l/ is velarized after a vowel or before a consonant at the end of a syllable. There is difference in the quality of /l/ in *life* [laɪf] and *file* [faɪɬ], or *clap* [klæp] and *talc* [tæɬk], or *feeling* [fi-lɪŋ] and *feel* [fiɬ]. In British English /l/ is usually not velarized when it is before a vowel, as in *lamb* [læm] or *swelling* [swɛ-lɪŋ], but it is velarized when word final or before a consonant, as in *ball* [bɔɬ] and *filled* [fɪɬd]. Also compare the /l/ in *kill it* [kɪ-lɪt] with the one in *kill them* [kɪl-ðɛm]. Most people don't have a velarized /l/ in *kill it*, despite the fact that it is seemingly at the end of a word (Ladefoged 2006). This is because *kill it* acts like a word with two syllables, and /l/ is not velarized because it is syllable-initial in the sound sequence [kɪ-lɪt].

Observations such as these are hard to explain unless we consider the syllable to be a significant unit in speech production. We will see in the following sections that it is difficult to describe English or, indeed, any language without considering syllables as utterance units.

6. Syllable weight and stress placement

In many stress languages, including English, stress is sensitive to a distinction called "syllable weight". A simple distinction would be between heavy and light syllables, defined by Hayes (2009:280) as follows:

Heavy syllable: syllable that either
- ends in a consonant, or
- has a long vowel or diphthong

Light syllable: syllable that ends in a short vowel

Thus, the weight of a syllable is determined by its rhyme structure. If the rhyme is non-branching (a short vowel without a coda), the syllable is light. If, on the other

hand, the rhyme is branching (has a short vowel followed by a coda, or has a long vowel or a diphthong with or without a coda), the syllable is heavy. The reduced vowel [ə]/[ɪ] is weightless and cannot carry stress (Yavaş 2006).

Languages for which syllable weight is important in determining stress (including English, Russian, Arabic, and many others) are said to be "quantity sensitive". Those languages for which syllable weight is irrelevant—i.e. where stress falls on a particular syllable irrespective of its internal structure (such as the last syllable in the case of French, or the initial syllable in the case of Czech)—are known as "quantity insensitive" (Davenport and Hannahs 2005). English and other languages of the first group require more complex rules of stress placement. In English, stress placement depends partly on syllable weight, with heavy syllables tending to receive stress. However, this is not a firm rule, and many exceptions exist. Besides syllable weight, three other factors combine to determine stress placement: penultimate stress tendency, grammatical category, and morphological structure.

In discussing stress placement in English, the location of syllables is distinguished by the terms ult (the last syllable), penult (the syllable before the ult), and antepenult (the syllable before the penult). Many languages, including English, show a strong tendency toward penultimate stress. Hayes (2009:283) proposes some crucial generalizations:

> If the penult is light, then (assuming enough syllables are present), the antepenult gets the stress. If the penult is heavy, or there are only two syllables, then penult get stressed, and in the monosyllable words, the final is stressed.

Yavaş (2006) points to the role of grammatical function in determining stress placement. The stress patterns of nouns and adjectives are similar enough to warrant treating them as a single category. In disyllabic nouns and adjectives, the penult receives the default stress. Below are some examples from both categories:

Nouns	Adjectives
agent [ˈe-dʒənt]	*absent* [ˈæb-sənt]
balance [ˈbæ-ləns]	*modest* [ˈmɑ-dɪst]
problem [ˈprɑ-bləm]	*common* [ˈkɑ-mən]

In trisyllabic and longer nouns, the formula is as follows: stress the penult if possible (heavy/branching rhyme); otherwise the next syllable to the left, regardless of syllable weight:

Three syllables		More than three syllables
tomato [tə-ˈme-to]	*animal* [ˈæ-nə-məl]	*barracuda* [ˌbæ-rə-ˈku-də]
aroma [ə-ˈro-mə]	*algebra* [ˈæl-dʒə-brə]	*asparagus* [ə-ˈspæ-rə-gəs]
diploma [dɪ-ˈplo-mə]	*vitamin* [ˈvaɪ-tə-mɪn]	*apocalypse* [ə-ˈpɑ-kə-ˌlɪps]

The words in the leftmost column receive stress on the penult, because their penults are stressable (the first four because of their long vowels or diphthong nuclei, and the last two because of the closed rhyme). The words in the second trisyllabic group receive stress on the antepenult because their penults all have the reduced vowel [ə]/[ɪ] nuclei, which are weightless and cannot carry stress.

If nouns and adjectives revolve around the penult, the equivalent for verbs is the ult. The general tendency is as follows: stress goes to the ult if heavy (branching rhyme); if not, it goes to the next left syllable, as shown in the following examples:

Heavy ult stressed	Unstressable ult, thus penult stressed
achieve [ə-ˈʧiv]	*finish* [ˈfɪ-nɪʃ]
admit [əd-ˈmɪt]	*canvas* [ˈkæn-vəs]
agree [ə-ˈgri]	*surface* [ˈsɝ-fɪs]

The verbs in the right column have unstressable ults because they are all with the reduced vowel [ə]/[ɪ] nuclei.

A final significant factor affecting stress placement of English words is morphological structure. Since the addition of prefixes does not change word stress, the presentation will be on the varying effects of suffixes. These are classified by Yavaş (2006:160) as follows:

a. stress-bearing (-attracting) suffixes
b. stress-shifting (fixing) suffixes
c. stress-neutral suffixes

The stress-bearing suffixes in group (a) are always heavy syllables. However, the stress-shifting suffixes in group (b), when added to a root, shift the stress from its original position to the syllable immediately preceding the suffix regardless of the syllable weight.

These four factors—syllable weight, penultimate tendency, grammatical category, and morphological structure—interact with each other as parameters or constraints to determine stress placement. For example, in *asparagus* [ə-ˈspæ-rə-gəs], although the antepenult is light, it gains the stress because the penult is unstressable (having the

reduced vowel [ə]/[ɪ] nuclei). Also, the suffix *-ity* in *popularity* [ˌpɑ-pjə-ˈlæ-rə-tɪ], *personality* [ˌpɝ-sə-ˈnæ-lə-tɪ], and *electricity* [ɪ-ˌlɛk-ˈtrɪ-sə-tɪ] shifts the stress to the syllable immediately before it regardless of syllable weight. The resulting words are resyllabified after the suffixes are added. For example, the letter *c* in *electric* [ɪ-ˈlɛk-trɪk] shifts to the onset of the penult of the word *electricity* [ɪ-ˌlɛk-ˈtrɪ-sə-tɪ] with the addition of the suffix *-ity*. The corresponding phoneme for the final letter *c* in *electric* [ɪ-ˈlɛk-trɪk] is /k/, but the same letter *c* has the corresponding phoneme /s/ in *electricity* [ɪ-ˌlɛk-ˈtrɪ-sə-tɪ]. With the addition of *-ity* and resyllabification, the letter *c* joins the letter *i* in the penult, which changes the sound because of one of the grapheme-phoneme correspondence rules: The corresponding phoneme for letter *c* is /s/ when followed by a tautosyllabic letter *e*, *i*, or *y*. This shows that the consonant /s/ in *electricity* [ɪ-ˌlɛk-ˈtrɪ-sə-tɪ] belongs to the penult instead of the antepenult, and that the antepenult is light without the consonant /s/ but still gains stress regardless of the syllable weight.

7. The principles of English spoken syllabification

English speakers follow at least two universal principles and four language-specific constraints of spoken syllabification.

7.1 Universal principles

(1) The Sonority Sequencing Principle (SSP). One of the most frequently-discussed aspects of phonotactic patterns is the sonority indices of sounds (e.g. Saussure 1916, Hooper 1972, 1976, Steriade 1982, Selkirk 1984, Hogg and McCully 1987, Clements 1990, Blevins 1995, Zec, 1995, 2007). The "sonority scale" (Saussure 1916), known as the sonority cycle (Clements 1990), ranks segments along a sonority scale such that the preferred syllable type shows a sonority profile that rises maximally toward the peak (nucleus) and falls minimally toward the end of the syllable. The determination of a syllable's nucleus, and the order of segments within onset and coda, is largely determined by this scale. It assumes that the organization of intra- and cross-syllabic segments is driven by the SSP; i.e., that a steady rise in sonority from the edges of a syllable to its center represents the ideal form (e.g. Clements 1988, Vennemann 1988). In many languages, however, it is possible to find acceptable syllables in which the segments in the onset or coda are in the "wrong" order, as in the case of the English words *start* [stɑrt], *spring* [sprɪŋ], and *skirt* [skɝt]. Each of these has a fricative before a stop in the onset (i.e. falling sonority), while the codas in *fox* [fɑks] and *adze* [ædz] exhibit rising sonority (with a stop before a fricative). A 10-point scale is proposed by

Hogg and McCully (1987:33) shown as below:

Sounds	**Sonority values**	**Examples**
Low vowels	10	/æ,ɑ /
Mid vowels	9	/e,o/
High vowels (and glides)	8	/i,u/
Flaps	7	/ɾ/
Laterals	6	/l/
Nasals	5	/n,m,ŋ/
Voiced fricatives	4	/v,ð,z/
Voiceless fricatives	3	/f,θ,s/
Voiced stops	2	/b,d,g/
Voiceless stops	1	/p,t,k/

(2) The Maximal Onset Principle (MOP). The same sequences of sounds are sometimes syllabified differently in different words. We will illustrate this phenomenon with the words *temptation* and *complain*, whose respective syllabifications are [tɛmp-ˈte-ʃən] and [kəm-ˈplen]. Our focus will be the [mp] sequence the two words share. As the syllabifications make clear, the same sequence behaves differently in the two words. While in *temptation* [tɛmp-ˈte-ʃən] the [mp] sequence is the double coda of the first syllable, in *complain* [kəm-ˈplen], the two sounds fall into separate syllables; [m] belongs to the coda of the first syllable, and [p] is part of the double onset of the second syllable. The reason for this difference is what is allowed as maximal onset in English. Since [pt] is not a possible onset, [p] has to stay in the first syllable of *temptation*. In *complain*, however, [p] is part of the onset of the second syllable because [pl] is a permissible onset in English.

Dividing the word *complain* as *[kəmp-len] would not have resulted in any violation of English onsets or codas, because both [kəmp] and [len] are permissible in the language. However, doing this would have meant maximizing the coda. The observed syllabification [kəm-ˈplen], on the other hand, follows the maximization of allowed onset in English. Assigning intervocalic consonants as onsets of the following syllable rather than coda of the preceding syllable forms the basis of the universal constraints, and this is derived from the fact that onsets are more basic than codas. All languages, without a single exception, have CV (open) syllables, whereas many languages may lack VC (closed) syllables.

When the phonological environment allows this, words are divided so that the maximal number of consonants occurs in the onset of a syllable. Indeed, in several influential theories of syllabification (e.g. Pulgram 1970, Kahn 1976, Selkirk 1982),

the MOP is the basic foundation upon which English syllabification rests. Given the choice, languages seem to prefer to assign consonants to onsets. This can easily be illustrated with the English words *apart* [ə-ˈpɑrt], *apply* [ə-ˈplaɪ], and *astride* [ə-ˈstraɪd]. More than three consonants will, of course, force a split into coda and onset, but again, with the maximal number of consonants going into the onset: *instruct* [ɪn-ˈstrʌkt], *express* [ɪk-ˈsprɛs], and *explain* [ɪk-ˈsplen].

7.2 Language-specific phonotactic constraints

(1) The principle of legality. A principle of legality has been proposed (e.g. Hooper 1972, Pulgram 1970, Selkirk 1982, Vennemann 1988), such that each syllable of a word, taken individually, is a possible word of the language.

The pair *attractive*: *Atlanta* offer an interesting contrast. The MOP would suggest [ə-ˈtræk-tɪv], *[ə-tlæn-tə], but since the latter results in the illegal onset *tl-, the syllabification becomes [ət-ˈlæn-tə]. A clue is found in the allophone of /t/, which is aspirated in the case of the first /t/ in *attractive* [ə-ˈtʰræk-tɪv], but unreleased in the case of the first /t/ in *Atlanta* [ətˀ-ˈlæn-tə]. This is a classic illustration of the interaction of the MOP with the principle of legality concerning which phoneme combinations are permitted in onsets in the language (e.g. Hooper 1972, Pulgram 1970, Selkirk 1982, Treiman and Zukowski 1990, Redford and Randall 2005). It means that the MOP is a basic rule, and needs to function under language-specific phonotactic constraints. Therefore, the combination of the two rules is as follows: make onsets as large as possible, while not violating phonotactic rules.

(2) The quality of the preceding vowel. According to Pulgram (1970), English allows open syllables with tense/long vowels, but not with lax/short vowels. In words with a long vowel in the preceding syllable, the VV.CV(V) pattern predominates over the VVC.V(V) pattern; with a short vowel in the preceding syllable VC.V(V) more readily preferred. The ambisyllabic $VC_1.C_1V(V)$ pattern occurs more often with a short vowel than a long vowel in the preceding syllable. Ambisyllabicity as used here occurs when an intervocalic consonant is a single segment that is in the coda of the preceding syllable and in the onset of the following syllable. Kahn (1976) popularized this notion to account for diverse phonological phenomena in the pronunciation of English and specified the conditions of double affiliation. Nevertheless, the syllable affiliation of such intervocalic consonants has frequently been a source of debate among phonologists (cf. Pulgram 1970, Hoard 1971, Kahn 1976, Bailey 1978, Selkirk 1982, Treiman and Danis 1988a, Gillis and De Schutter 1996).

(3) The Stress Principle. In addition, it has been claimed that consonants are drawn to stressed vowels in general (e.g. Bailey 1978, Hoard 1971) or to stressed “short”

vowels in particular (e.g. Pulgram 1970). Treiman and Zukowski (1990:80) incorporate the effect of stress in a separate principle of syllabification, which they call the Stress Principle: "A stressed syllable (or a stressed vowel) attracts consonants." Syllables with short vowels tend to attract consonants to become heavy and stress-attracting. This explains the syllabification of words like *semester* [sə-ˈmɛs-tɚ] and *canasta* [kə-ˈnæs-tə]. Here the stress and shortness of the second vowel shifts [s] to become the coda of the second syllable, which then becomes heavy and stress-attracting.

However, this principle is relatively weak, and may not exist at all, since English speakers sometimes end syllables with stressed short vowels. *Merriam-Webster's Collegiate Dictionary* (2008) stresses the first syllable of *happen* [ˈhæ-pən], *clever* [ˈklɛ-vɚ], *river* [ˈrɪ-vɚ], *coming* [ˈkʌ-mɪŋ], and *pocket* [ˈpɑ-kɪt] despite the fact that each of the stressed syllables ends in a short vowel. Core clusters cannot appeal to the Stress Principle, either. Consider *problem* [ˈprɑ-bləm], *Madrid* [ˈmæ-drɪd], *address* [ˈæ-drɛs], *photography* [fə-ˈtɑ-grə-fɪ], and *vacuum* [ˈvæ-kjʊ-əm], in which the first consonant of the intervocalic core cluster is not attracted to the stressed short vowel. The stressed short vowel can only draw the first consonant [s] of /s/+stop clusters in words such as *master* [ˈmæs-tɚ], *aspect* [ˈæs-pɛkt], *muscular* [ˈmʌs-kjə-lɚ], and *history* [ˈhɪs-trɪ].

(4) Spelling of the intervocalic consonant. Double spelling leads to ambisyllabic syllabification. For example, an ambisyllabic response will be reported if [ræb-bɪt] is produced when asked to slowly repeat the word *rabbit*. As pointed out by Treiman and Danis (1988a), people are more likely to treat an intervocalic consonant as ambisyllabic if the consonant is spelled with a doubled grapheme (e.g. *fellow*, *comma*, *rabbit*) than when it is spelled with a single grapheme (e.g. *melon*, *lemon*, *habit*) or a combination of different letters (e.g. *psycho*, *feather*). Collier and De Schutter (1985) as well as De Schutter and Collier (1986) investigated Dutch syllabification in a large adult population and found similar tendencies to those reported by Treiman and Danis (1988a).

8. A problem of English spoken syllabification—ambisyllabicity

The syllabification of words such as [ˈʃɪ-mɚ], [ˈhæ-pən], [ˈbɛ-tɚ], [ˈbɑ-ro], and [ˈsʌ-mɚ] seems problematic because there is a conflict between the MOP and the Stress Principle. While the MOP dictates that the first syllables of each of these words be light (open syllables with lax/short vowels), the stress which falls on this very syllable contradicts the Stress Principle that light syllables should not receive stress. Linguists invoke the concept of ambisyllabicity whereby the consonant in question is

treated as behaving both as the coda of the preceding and the onset of the following syllable at the same time (e.g. Pulgram 1970, Kahn 1976, Kager 1989). The present-day English writing system suggests that some writers and speakers do perceive consonants like the /m/ of *shimmer* [ˈʃɪ-mɚ] as ambisyllabic, since so many of these consonants are written with two graphemes despite being single phonemic segments: *hap·pen* [ˈhæ-pən], *bet·ter* [ˈbɛ-tɚ], *bor·row* [ˈbɑ-ro], and *sum·mer* [ˈsʌ-mɚ]. A structure like the following is proposed by McCully (2009:104):

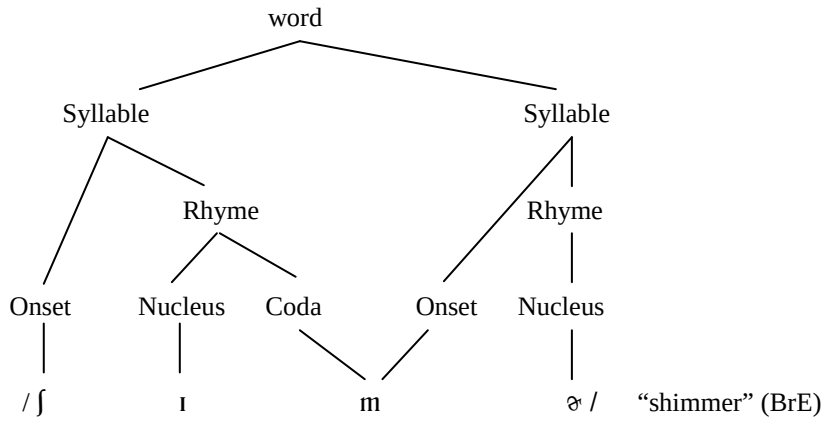

Figure 1. Ambisyllabicity of the /m/ of shimmer[6]

In this structure, the coda of the first syllable is filled, and the MOP is satisfied, since the onset of the second syllable is filled. It is suggested that ambisyllabicity is a real phenomenon of present-day English (McCully 2009).

However, Selkirk (1982) claims that ambisyllabicity is unnecessary. In Redford and Randall's (2005) study, vowel quality in terms of tense/lax distinctions had no effect on syllabification. The geminate realizations of orthographically doubled word-medial consonants were not found in Content, Meunier, Kearns, and Frauenfelder's study (2001). In English, geminate consonants can occur only across morpheme boundaries, as in a word containing two morphemes, such as *unknown* [ʌnˈnoʊn], *guileless* [ˈgaɪl-ləs], and *wholly* [ˈhol-lɪ] (Ladefoged 2006).

Besides, in view of the principles discussed above, the word *shimmer* should be syllabified simply as [ˈʃɪ-mɚ] even though this syllabification leaves the first syllable ending in a stressed short vowel. Although this syllabification violates the Stress Principle, it follows the MOP. It is not problematic in the context of the above discussion, which suggests that the MOP is stronger than the Stress Principle. Stress placement in English is dependent only in part on syllable weight. For heavy syllables to attract stress is only a tendency; there are cases in which the rules will stress a light

[6] Adopted from McCully (2009:104).

syllable. When determining stress placement, syllable weight is not the only factor. The stressed syllable can be light because of the interaction of several factors related to stress placement, such as syllable weight, penultimate-stress tendency, grammatical category, and morphological structure.

Further, the orthographic irregularity that concerns the spelling of single intervocalic consonants in words like *panic* [ˈpæ-nɪk] or *bonnet* [ˈbɑ-nət] has received attention. Both words have a single intervocalic phoneme, /n/, but are represented by single or double graphemes. Using a syllable reversal task, Treiman and Danis (1988a) reported that American college students were much more likely to duplicate the intervocalic phonemes and treat them as ambisyllabic when represented by two graphemes. Scholars hypothesize that some of the ambisyllabicity results obtained from adults may well be ascribed to the influence of spelling conventions (e.g. Treiman and Danis 1988a, Derwing 1992). This inconsistent correspondence between phonology and spelling may well influence adults' spoken syllabifications: ambisyllabic splitting may possibly be triggered by orthographic features of the words in question (Gillis and De Schutter 1996).

In fact, the potential of the development of literacy to influence syllabification behavior in spoken words has gained considerable currency in recent years (e.g. Derwing 1992, Gillis and De Schutter 1996, Treiman et al. 2002, Goslin and Floccia 2007). When phonological and orthographic representations are at odds, the discrepancy between these forms was shown to cause segmental uncertainty in adults, resulting in ambisyllabicity and reduced segmentation consistency. As pointed out by Treiman et al. (2002), the influence of literacy in metalinguistic tasks could be due to the unconscious spelling of words, rather than a true modification of phonological representations.

9. Exceptional behavior about /s/+stop clusters

In general, English onset clusters are either (a) /s/+consonant or (b) obstruent + approximant. The pattern of obstruent + approximant is common in many languages, including English, and can be accounted for by the SSP. Thus, the expected pattern is that, going from the first to the second segment, the sonority level will rise. Such is the case in the overwhelming majority of English double onsets (e.g. *play* [pl̩e], *cry* [kraɪ], *quick* [kwɪk], *new* [nju]). The violations of the SSP are /s/+stop clusters (/sp, st, sk/) in which the sonority level drops, instead of rises, going from the first to the second segment.

In fact, this exceptional behavior of /s/+consonant is also found in several other languages (e.g. Trommelen 1984, Kager and Zonneveld 1985/1986, Steriade 1988,

Davis 1990, Fikkert 1994, Barlow 2001, Yavaş 2010). Scholars have proposed a special "adjunct" status for /s/+consonant clusters in order to explain these structural oddities (e.g. Giegerich 1992, Kenstowicz 1994). In this proposal, /s/+consonant clusters are a direct dependent of the syllable, rather than being syllabified under the onset position. This creates two categories of cluster types—"true clusters" and "adjunct clusters" illustrated by Yavaş (2010:171) in Figure 2.

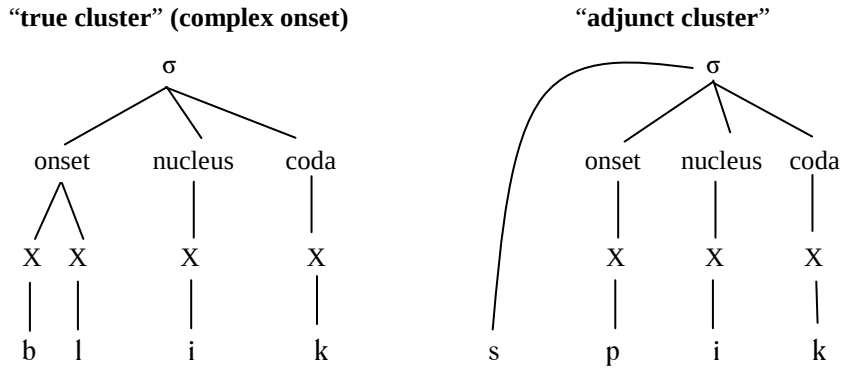

Figure 2. Metrical trees illustrating true and adjunct clusters[7]

The distinction between "true clusters" and "adjunct clusters" can be compared to the Stress Principle. For example, the first consonant of the intervocalic "true cluster" is not attracted to the stressed short vowel in words *problem* [ˈprɑ-bləm], *Madrid* [ˈmæ-drɪd], *address* [ˈæ-drɛs], *photography* [fə-ˈtɑ-grə-fɪ], *vacuum* [ˈvæ-kjʊ-əm], etc. The stressed short vowel can draw the first consonant [s] of /s/+stop clusters in words *master* [ˈmæs-tɚ], *aspect* [ˈæs-pɛkt], *muscular* [ˈmʌs-kjə-lɚ], *history* [ˈhɪs-trɪ], etc. One interpretation of these results is that the two consonants of a true cluster are tied more tightly than the two consonants of an /s/+stop cluster. The /s/ of an /s/+stop cluster is in an "adjunct" status and can be drawn to the preceding syllable if the preceding syllable ends in a stressed short vowel.

10. Fundamental generalizations of English spoken syllabification

An English syllable contains at most three optional consonants followed by an obligatory vowel, and then four optional consonants. This formula is applicable to monosyllabic English words. Two or more different types of syllables may combine to form polysyllabic words, but they do not contain as many complex syllables as the monosyllabic words do. For example, the word *electricity* consists of five syllables: [ɪ-lɛk-trɪ-sə-tɪ] (V-CVC-CCV-CV-CV).

[7] Adopted from Yavaş (2010:171)

A specific proposal that follows from work on the relationship between prosodic structure and jaw movement (e.g. Stone 1981, de Jong et al. 1993, Harrington et al. 1995, Erickson 1998, Erickson et al. 1998) as well as from work on the relationship between sound sequencing and jaw movement (e.g. MacNeilage 1998, MacNeilage and Davis 2000, MacNeilage et al. 2000) is that sequences that are easily coarticulated within the open-close cycle of the jaw are grouped together for speech output. Grouping segments in this way allows a speaker to work with the biomechanical dependencies between the lips, tongue, and jaw instead of against them. Segment sequences that are coarticulated within a single jaw cycle parallel the preferred intra-syllable sequencing patterns described by the SSP, because the sonority hierarchy parallels an articulatory openness hierarchy (Lindblom 1983, Browman and Goldstein 1989, Butt 1992).

The composition of syllables follows universal syllabification constraints (such as the SSP and the MOP) and language-specific phonotactics, and leads to the preferred CV organization, either [CVCV → CV + CV] or [CVCCV → CV + CCV]. The singleton intervocalic consonant goes to the following syllable. The two (or even three) intervocalic consonants, under the right circumstances (rising-sonority sequences or legal clusters), can together initiate a syllable as the onset of the following syllable. The resulting CV or CCV syllable provides an alternating articulatory pattern beginning with a tight constriction (consonant) and ending with an open vocal tract (vowel), in a kind of rhythm that may somehow be easier for the speaker as well as the listener (Krakow 1999).

There are eight fundamental generalizations of English spoken syllabification derived from the above discussion in the present study:

(1) Every vowel or syllabic consonant sound in a word creates a syllable, so there are as many syllables as there are vowel or syllabic consonant sounds. Syllables are determined by the vowel phonemes, not by the number of vowel graphemes.

	Vowel Graphemes	Vowel Phonemes
daughter [ˈdɔ-tɚ]	3	2
beautiful [ˈbju-tə-fəl]	5	3
picture [ˈpɪk-tʃɚ]	3	2
television [ˈtɛ-lə-vɪ-ʒən]	5	4
bottle [ˈbɑ-tl̩]	2	2

(2) According to the MOP, a single consonant between vowels always goes with the following vowel: *beautiful* [ˈbju-tə-fəl]. The only exception to this is the sound [ŋ] since

no syllable can begin with [ŋ]: *singer* [ˈsɪŋ-ɚ].

(3) According to the MOP and the SSP, intervocalic consonant clusters should be assigned to the following syllable, provided the resulting cluster is legal: *problem* [ˈprɑ-bl̩əm], *approve* [ə-ˈp̩ruv], *response* [rɪ-ˈs̩pɑns], *request* [rɪ-ˈkw̩ɛst], and *abuse* [ə-ˈb̩jus]. English legal onset clusters are either (a) /s/+consonant or (b) obstruent + approximant, and triple onsets can be described as an addition of /s/ to voiceless stop + approximant double onsets. Therefore, there are five inventories of legal onset clusters which can occur in the onset: (i) [r] is the concluding consonant; (ii) [l] is the concluding consonant; (iii) [w] is the concluding consonant; (iv) [j] is the concluding consonant; (v) [s] is the beginning consonant (Yavaş 2006).

Since consonant clusters cause ESL/EFL learners severe pronunciation problems, it seems necessary to list the inventory of the intervocalic consonant clusters of English so that the pronunciation of consonant clusters becomes achievable through practice:

(i) [r] is the concluding consonant

[br]	*eyebrow*	[ˈaɪ-ˌbraʊ]
[kr]	*recreate*	[ˌri-krɪ-ˈet]
[dr]	*wardrobe*	[ˈwɔr-ˌdrob]
[fr]	*diffract*	[dɪ-ˈfrækt]
[gr]	*ingredient*	[ɪn-ˈgri-dɪ-ənt]
[pr]	*approve*	[ə-ˈpruv]
[tr]	*betray*	[bɪ-ˈtre]
[θr]	*breakthrough*	[ˈbrek-ˌθruˌ]
[ʃr]	*enshrine*	[ɪn-ˈʃraɪn]
[skr]	*discreet*	[dɪ-ˈskrit]
[spr]	*express*	[ɪk-ˈsprɛs]
[str]	*extreme*	[ɪk-ˈstrim]

(ii) [l] is the concluding consonant

[bl]	*problem*	[ˈprɑ-bləm]
[kl]	*decline*	[dɪ-ˈklaɪn]
[fl]	*afflict*	[ə-ˈflɪkt]
[gl]	*neglect*	[nɪ-ˈglɛkt]
[pl]	*implicit*	[ɪm-ˈplɪsɪt]
[sl]	*asleep*	[ə-ˈslip]
[skl]	*exclude*	[ɪk-ˈskluˌd]
[spl]	*explosive*	[ɪk-ˈsplo-sɪv]

(iii) [w] is the concluding consonant

[dw]	*dwell*	[dwɛl]
[gw]	*penguin*	[ˈpɛŋ-gwɪn]
[kw]	*request*	[rɪ-ˈkwɛst]
[sw]	*upswing*	[ʌp-ˈswɪŋ]
[tw]	*intertwine*	[ˌɪn-tɚ-ˈtwɪn]
[θw]	*athwart*	[ə-ˈθwɔrt]
[skw]	*exquisite*	[ɪk-ˈskwɪ-zɪt]

(iv) [j] is the concluding consonant

[bj]	*abuse*	[ə-ˈbjʉs]
[pj]	*reputation*	[ˌrɛ-pjə-ˈte-ʃən]
[tj]	*attuned*	[ə-ˈtjʉnd]
[dj]	*adduce*	[ə-ˈdjʉs]
[kj]	*incubus*	[ˈɪŋ-kjə-bəs]
[fj]	*infuse*	[ɪn-ˈfjʉz]
[vj]	*interview*	[ˈɪn-tɚ-ˌvjʉ]
[hj]	*dehumidifier*	[ˌdi-hjʉ-ˈmɪ-dɪ-ˌfaɪ-ɚ]
[mj]	*amuse*	[ə-ˈmjʉz]
[nj]	*manuscript*	[ˈmæ-njə-skrɪpt]
[skj]	*excuse*	[ɪk-ˈskjʉs]
[spj]	*dispute*	[dɪ-ˈspjʉt]
[stj]	*astute*	[ə-ˈstjʉt]

(v) [s] is the beginning consonant

[sk]	*escape*	[ə-ˈskep]
[sp]	*response*	[rɪ-ˈspɑns]
[st]	*distinctive*	[dɪ-ˈstɪŋk-tɪv]
[sm]	*blacksmith*	[ˈblæk-ˌsmɪθ]
[sn]	*ensnare*	[ɛn-ˈsnɛr]
[sf]	*atmosphere*	[ˈæt-mə-ˌsfɪr]

(4) Divide intervocalic consonant clusters if they are not legal, but still follow the MOP: *excrete* [ɪk-ˈskrit], *complain* [kəm-ˈplen], *country* [ˈkʌn-trɪ], etc.

(5) Treat intervocalic /s/+stop clusters ([sk][sp][st]) differently than other clusters. If an /s/+stop cluster follows a stressed short vowel, it appeals to the Stress Principle—i.e. /s/ is attracted to become the coda of the stressed syllable rather than the onset of the following syllable: *aspect* [ˈæs-pɛkt], *semester* [sə-ˈmɛs-tɚ], *history* [ˈhɪs-trɪ], etc. Otherwise, they are syllabified to become the onset of the following syllable: *canister*

[ˈkæ-nɪ-stɚ], *escape* [ə-ˈskep], *response* [rɪ-ˈspɑns], etc.

(6) According to the MOP, divide the vowel sound [ɝ] into [ʌ-r] when a vowel follows the sound [ɝ].

hurry	[ˈhɝɪ;ˈhʌ-rɪ]
hurricane	[ˈhɝɪ-ˌken;ˈhʌ-rɪ-ˌken]
curry	[ˈkɝɪ;ˈkʌ-rɪ]
current	[ˈkɝənt;ˈkʌ-rənt]

(7) Syllabify compound words according to word boundaries if they have secondary stress which is always in parallel with syllable boundaries.

handout	[ˈhænd-ˌaʊt; ˈhæn-daʊt]
silkworm	[ˈsɪlk-ˌwɝm]
taxpayer	[ˈtæks-ˌpe-ɚ]
alarm clock	[ə-ˈlɑrm-ˌklɑk]
lipstick	[ˈlɪp-ˌstɪk]

(8) Spoken syllabification follows the principle of actual pronunciation, maintaining the integrity of prefixes only, while written syllabification retains the integrity of both prefixes and suffixes as discussed above.

dishonest	[dɪs-ˈɑ-nɪst]
unable	[ʌn-ˈe-bl̩]

cf. the word *discuss*, whose spoken syllabification should be [dɪ-ˈskˉʌs] since *dis-* is not a prefix here. With the word *discovery*, the spoken syllabification can be [dɪs-ˈkʰʌ-və-rɪ] or [dɪ-ˈskˉʌ-və-rɪ], depending whether or not *dis-* is considered a prefix.

11. Conclusion

The present study reviews a variety of relevant research, and results in several applications for ESL/EFL teaching: First of all, it suggests guidelines for spoken syllabification of English polysyllabic words. Second, by comparing the two types of syllabification, it clarifies the different principles used for breaking the written language and the spoken language. Third, it lists the five inventories of intervocalic legal onset clusters (see the third point of Section 10) so that the pronunciation of clusters becomes achievable. Fourth, the generalizations of spoken syllabification

listed in the current study are applicable to clusters across word boundaries and make these clusters easier to pronounce. For example, the phrase *find it* can be pronounced as [faɪn-dɪt] and *thank you* can be pronounced as [θæŋ-kju]. Fifth, stress is a suprasegmental feature of utterances, and so it applies not to individual vowels and consonants but to whole syllables. Therefore, the proper location of stress depends on appropriate syllabification, as the present study suggests.

In light of the research and discussion available today on the syllable in speech production, it seems that we have come a long way since Kenstowicz and Kisseberth (1979:255-256) remarked that "…the syllable is probably the most elusive of all phonological/phonetic notions."

References

Abercrombie, David. 1967. *Elements of General Phonetics*. Edinburgh: Edinburgh University Press.

American Heritage Dictionary of the English Language, The, 2nd college edn. 1985. Boston: Houghton Mifflin.

Anderson, Janet I. 1983. The difficulties of English syllable structure for Chinese ESL learners. *Language Learning and Communication* 2:53-61.

Bailey, Charles-James Nice. 1978. *Gradience in English Syllabication and a Revised Concept of Unmarked Syllabication*. Bloomington, IN: Indiana University Linguistics Club.

Barlow, Jessica A. 2001. Preliminary typology of initial clusters in acquisition. *Clinical Linguistics and Phonetics* 15:9-13.

Bauman-Waengler, Jacqueline. 2009. *Introduction to Phonetics and Phonology: From Concepts to Transcription*. Boston: Pearson.

Blevins, Juliette. 1995. The syllable in phonological theory. *The Handbook of Phonological Theory*, ed. by John A. Goldsmith, 206-244. Cambridge, MA: Blackwell.

Browman, Catherine P., and Louis G. Goldstein. 1989. Articulatory gestures as phonological units. *Phonology* 6:201-251.

Butt, Matthias. 1992. Sonority and the explanation of syllable structure. *Linguistica Berichte* 137:45-67.

Cambridge International Dictionary of English. 1995. Cambridge: Cambridge University Press.

Cholin, Joana, Willem J. M. Levelt, and Niels O. Schiller. 2006. Effects of syllable frequency in speech production. *Cognition* 99:205-235.

Cholin, Joana, Niels O. Schiller, and Willem J. M. Levelt. 2004. The preparation of syllables in speech production. *Journal of Memory and Language* 50:47-61.

Chow, Bonnie W.-Y., Catherine McBride-Chang, and Stephen Burgess. 2005. Phonological processing skills and early reading abilities in Hong Kong Chinese kindergarteners learning to read English as a second language. *Journal of Educational Psychology* 97:81-87.

Clements, George N. 1988. The role of the sonority cycle in core syllabification. *Working Papers of the Cornell Phonetics Laboratory* 2:1-68.

Clements, George N. 1990. The role of the sonority cycle in core syllabification. *Papers in Laboratory Phonology I: Between Grammar and Physics of Speech*, ed. by John Kingston and Mary Beckman, 283-333. Cambridge: Cambridge University Press.

Collier, René, and Georges De Schutter. 1985. Syllaben als klankgroepen in het Nederlands [Syllables as sound groups in Dutch]. *Antwerp Papers in Linguistics* 47:1-58.

Content, Alian, Christine Meunier, Ruth K. Kearns, and Uli H. Frauenfelder. 2001. Sequence detection in pseudowords in French: Where is the syllable effect?. *Language and Cognitive Processes* 16:609-636.

Davenport, Mike, and S. J. Hannahs. 2005. *Introducing Phonetics and Phonology*, 2nd edn. London: Hodder Arnold.

Davis, Stuart. 1990. Italian onset structure and the distribution of *il* and *lo*. *Linguistics* 28:43-55.

de Jong, Kenneth, Mary E. Beckman, and Jan Edwards. 1993. The interplay between prosodic structure and coarticulation. *Language and Speech* 36:1355-1367.

Derwing, Bruce L. 1992. A “pause-break” task for eliciting syllable boundary judgments from literate and illiterate speakers: Preliminary results for five diverse languages. *Language and Speech* 35:219-235.

De Schutter, Georges, and René Collier. 1986. Intuïtieve syllabisering in het Nederlands [Intuitive syllabification in Dutch]. *De Nieuwe Taalgids* 79:441-452.

Duanmu, San. 2006. Chinese (Mandarin): Phonology. *Encyclopedia of Language and Linguistics*, 2nd edn., ed. by Keith Brown, 351-355. Oxford: Elsevier Publishing House.

Eckman, Fred R. 1981. On the naturalness of interlanguage phonological rules. *Language Learning* 31:195-216.

Eckman, Fred R. 1991. The structural conformity hypothesis and the acquisition of consonant clusters in the interlanguage of ESL learners. *Studies in Second Language Acquisition* 13:23-41.

Encarta World English Dictionary. 1999. London: Bloomsbury.

Erickson, Donna. 1998. Effects of contrastive emphasis on jaw opening. *Phonetica* 55:147-169.

Erickson, Donna, Osama Fujimura, and Bryan Pardon. 1998. Articulatory correlates of emotion control: Emotion and emphasis. *Language and Speech* 41:399-417.

Ferrand, Ludovic, Juan Segui, and Jonathan Grainger. 1996. Masked priming of word and picture naming: The role of syllabic units. *Journal of Memory and Language* 35:708-723.

Ferrand, Ludovic, Juan Segui, and Glyn W. Humphreys. 1997. The syllable's role in word naming. *Memory and Cognition* 25:458-470.

Fikkert, Paula. 1994. On the Acquisition of Prosodic Structure. Doctoral dissertation, Leiden University.

Fowler, Carol A., Rebecca Treiman, and Jennifer Gross. 1993. The structure of English syllables and polysyllables. *Journal of Memory and Language* 32:115-140.

Garmon, Michael. 1990. *Psycholinguistics*. Cambridge: Cambridge University Press.

Giegerich, Heinz J. 1992. *English Phonology.* Cambridge: Cambridge University Press.

Gillis, Steven, and Georges De Schutter. 1996. Intuitive syllabification: Universals and language specific constraints. *Journal of Child Language* 23:487-514.

Goslin, Jeremy, and Caroline Floccia. 2007. Comparing French syllabification in preliterate children and adults. *Applied Psycholinguistics* 28:341-367.

Grant, Linda. 2000. *Well Said: Advanced English Pronunciation*, 2nd edn. Boston: Heinle & Heinle.

Harrington, Jonathan, Janet Fletcher, and Corinne Roberts. 1995. Coarticulation and the accented/unaccented distinction: Evidence from jaw movement data. *Journal of Phonetics* 23:305-322.

Hayes, Bruce. 2009. *Introductory Phonology*. Malden: Wiley-Blackwell.

Ho, Connie S.-H., and Peter Bryant. 1997. Phonological skills are important in learning to read Chinese. *Developmental Psychology* 33:946-951.

Hoard, James W. 1971. Aspiration, tenseness, and syllabification in English. *Language* 47:133-140.

Hogg, Richard, and Chris B. McCully. 1987. *Metrical Phonology: A Course Book*. Cambridge: Cambridge University Press.

Hooper, Joan B. 1972. The syllable in phonological theory. *Language* 48:525-540.

Hooper, Joan B. 1976. *An Introduction to Natural Generative Phonology*. New York: Academic Press.

Kager, René. 1989. *A Metrical Theory of Stress and Destressing in English and Dutch.* Dordrecht: Foris.

Kager, René, and Wim Zonneveld. 1985/1986. Schwa, syllables, and extrametricality in Dutch. *The Linguistic Review* 5:197-221.

Kahn, Daniel. 1976. Syllable-Based Generalizations in English Phonology. Doctoral dissertation, Massachusetts Institute of Technology.

Kenstowicz, Michael J. 1994. *Phonology in Generative Grammar.* Oxford: Blackwell.

Kenstowicz, Michael J., and Charles W. Kisseberth 1979. *Generative Phonology*. New York: Academic Press.

Kenworthy, Joanne. 1987. *Teaching English Pronunciation*. London: Longman.

Krakow, Rena A. 1999. Physiological organization of syllables: A review. *Journal of Phonetics* 27:33-54.

Ladefoged, Peter. 2006. *A Course in Phonetics*, 5th edn. Boston: Thomson Wadsworth.

Levelt, Willem J. M., and Linda Wheeldon. 1994. Do speakers have access to a mental syllabary?. *Cognition* 50:239-269.

Levelt, Willem J. M., Ardi Roelofs, and Aatje S. Meyer. 1999. A theory of lexical access in speech production. *Behavioral and Brain Sciences* 22:1-75.

Liberman, Mark Y. 1975. The Intonational System of English. Doctoral dissertation, Massachusetts Institute of Technology.

Liberman, Mark Y., and Alan Prince. 1977. On stress and linguistic rhythm. *Linguistic Inquiry* 8:249-336.

Liberman, Isabelle Y., Donald Shankweiler, F. William Fischer, and Bonnie Carter. 1974. Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology* 18:201-212.

Lin, Li-chin. 2010a. The effects of phonological awareness training on L1 Chinese university students' English vocabulary retention. *Hsuan Chuang Humanities Journal* 10:117-134.

Lin, Li-chin. 2010b. The effect of phonological awareness training with computer-aided instruction on English vocabulary retention. *Papers in Constructing New Strategies for English Instruction*, ed. by Wei-yang Dai, Chung-shun Hsia, Yiu-nam Leung, and Hsing-chin Lee, 187-201. Taipei City: Crane.

Lin, Li-chin, and Jui-Chun Wu. 2006. The effect of syllabication on English vocabulary teaching to Chinese students. *Papers in New Aspects of English Language Teaching and Learning*, ed. by Yiu-nam Leung, Michael Jenks, and Chung-shun Hsia, 190-200. Taipei City: Crane.

Lindblom, Björn. 1983. Economy of speech gestures. *The Production of Speech*, ed. by Peter F. MacNeilage, 217-246. New York: Springer-Verlag.

MacNeilage, Peter F. 1998. The frame/content theory of evolution of speech production. *Behavioral and Brain Sciences* 21:499-546.

MacNeilage, Peter F., and Barbara L. Davis. 2000. On the origin of internal structure of word forms. *Science* 288:527-531.

MacNeilage, Peter F., Barbara L. Davis, Ashlynn Kinney, and Christine L. Matyear. 2000. The motor core of speech: A comparison of serial organization patterns in infants and languages. *Child Development* 71:153-163.

McBride-Chang, Catherine, and Connie S.-H. Ho. 2000. Developmental issues in Chinese children's character acquisition. *Journal of Educational Psychology* 92:50-55.

McCarthy, John, and Alan Prince. 1993. *Prosodic Morphology: Constraint Interaction and Satisfaction*. New Brunswick: Rutgers University.

McCarthy, Michael, Felicity O'Dell, and Ellen Shaw. 2001. *Vocabulary in Use Upper Intermediate*. Cambridge: Cambridge University Press.

McCully, Chris. 2009. *The Sound Structure of English*. Cambridge: Cambridge University Press.

Merriam-Webster's Collegiate Dictionary, 11th edn. 2008. Springfield: Merriam-Webster.

Miller, Sue F. 2005. *Targeting Pronunciation: The Intonation, Sounds, and Rhythm of American English*, 2nd edn. Boston: Houghton Mifflin.

Nespor, Maria, and Irene Vogel. 1986. *Prosodic Phonology*. Dordrecht: Foris.

Orion, Gertrude F. 1997. *Pronouncing American English: Sounds, Stress, and Intonation*, 2nd edn. Boston: Heinle & Heinle.

Oxford Advanced Learner's English-Chinese Dictionary, 6th edn. 2004. Oxford: Oxford University Press.

Prince, Alan, and Paul Smolensky. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar*. New Brunswick: Rutgers University.

Pulgram, Ernst. 1970. *Syllable, Word, Nexus, Cursus*. The Hague: Mouton.

Random House Compact Unabridged Dictionary, special 2nd edn. 1996. New York: Random House.

Redford, Melissa A., and Patrick Randall. 2005. The role of juncture cues and phonological knowledge in English syllabification judgments. *Journal of Phonetics* 33:27-46.

Redman, Stuart, and Ellen Shaw. 1999. *Vocabulary in Use Intermediate*. Cambridge: Cambridge University Press.

Roelofs, Ardi. 1997a. Syllabification in speech production: Evaluation of WEAVER. *Language and Cognitive Processes* 12:657-693.

Roelofs, Ardi. 1997b. The WEAVER model of word-form encoding in speech production. *Cognition* 64:249-284.

Roelofs, Ardi. 1999. Phonological segments and features as planning units in speech

production. *Language and Cognitive Process* 14:173-200.

Roelofs, Ardi. 2002. Syllable structure effects turn out to be word length effects: Comment on Santiago et al. (2000). *Language and Cognitive Process* 17:1-13.

Saussure, Ferdinand de. 1916. *Cours de Linguistique Genérale* [*Course in General Linguistics*]. Lausanne: Payot.

Schiller, Niels O., Antje S. Meyer, R. Harald Baayen, and Willem J. M. Levelt. 1996. A comparison of lexeme and speech syllables in Dutch. *Journal of Quantitative Linguistics* 3:8-28.

Selkirk, Elisabeth O. 1978. On prosodic structure and its relation to syntactic structure. *Nordic Prosody II*, ed. by Thorstein Fretheim, 111-140. Trondheim: Tapir.

Selkirk, Elisabeth O. 1982. The syllable. *The Structure of Phonological Representations II*, ed. by Harry van der Hulst and Norval Smith, 337-383. Dordrecht: Foris.

Selkirk, Elisabeth O. 1984. On the major class features and syllable theory. *Language Sound Structure: Studies in Phonology Presented to Morris Halle by His Teacher and Students*, ed. by Mark Aronoff and Richard T. Oehrle, 107-136. Cambridge, MA: MIT Press.

Small, Larry H. 2005. *Fundamentals of Phonetics: A Practical Guide for Students*, 2nd edn. Boston: Allyn and Bacon.

Snow, Catherine E., M. Susan Burns, and Peg Griffin. 1998. *Preventing Reading Difficulties in Young Children.* Washington, DC: National Academy Press.

Steriade, Donca. 1982. Greek Prosodies and the Nature of Syllabification. Doctoral dissertation, Massachusetts Institute of Technology.

Steriade, Donca. 1988. Reduplication and syllable transfer in Sanskrit and elsewhere. *Phonology* 5:73-155.

Stone, Maureen. 1981. Evidence for a rhythm pattern in speech production: Observations of jaw movement. *Journal of Phonetics* 9:109-120.

Sun, Shu-huei Cecilia. 2007. *American English Phonetics*, revised edn. Taipei City: Crane.

Treiman, Rebecca. 1989. The internal structure of the syllable. *Linguistic Structure in Language Processing*, ed. by Greg N. Carlson and Michael K. Tanenhaus, 27-52. Dordrecht: D. Reidel.

Treiman, Rebecca, and Catalina Danis. 1988a. Syllabification of intervocalic consonants. *Journal of Memory and Language* 27:87-104.

Treiman, Rebecca, and Catalina Danis. 1988b. Short-term memory errors for spoken syllables are affected by the linguistic structure of the syllables. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 14:145-152.

Treiman, Rebecca, and Andrea Zukowski. 1990. Toward an understanding of English

syllabification. *Journal of Memory and Language* 29:66-85.

Treiman, Rebecca, Judith A. Bowey, and Derrick Bourassa. 2002. Segmentation of spoken words into syllables by English-speaking children as compared to adults. *Journal of Experimental Child Psychology* 83:213-238.

Treiman, Rebecca, Carol A. Fowler, Jennifer Gross, Denise Berch, and Sarah Weatherston. 1995. Syllable structure or word structure? Evidence for onset and rime units with disyllabic and trisyllabic stimuli. *Journal of Memory and Language* 34:132-155.

Trommelen, Mieke. 1984. *The Syllable in Dutch: With Special Reference to Diminutive Formation.* Dordrecht: Foris.

Vennemann, Theo. 1988. *Preference Laws for Syllable Structure and the Explanation of Sound Change*. Berlin: Mouton de Gruyter.

Wagner, Richard K., Joseph K. Torgesen, and Carol A. Rashotte. 1994. Development of reading related phonological processing abilities: New evidence of bidirectional causality from a latent variable longitudinal study. *Developmental Psychology* 30:73-87.

Webster's New World Dictionary of American English, 3rd college edn. 1994. New York: Prentice Hall.

Weismer, Gary, Daniel Dinnsen, and Mary Elbert. 1981. A study of the voicing distinction associated with omitted, word-final stops. *Journal of Speech and Hearing Disorders* 46:320-328.

Wheeldon, Linda R., and Willem J. M. Levelt. 1995. Monitoring the time course of phonological encoding. *Journal of Memory and Language* 34:311-334.

Yavaş, Mehmet. 2006. *Applied English Phonology*. Oxford: Blackwell.

Yavaş, Mehmet. 2010. Sonority and the acquisition of /s/ clusters in children with phonological disorders. *Clinical Linguistics and Phonetics* 24:169-176.

Zec, Draga. 1995. Sonority constraints on syllable structure. *Phonology* 12:85-129.

Zec, Draga. 2007. The syllable. *The Cambridge Handbook of Phonology*, ed. by Paul de Lacy, 161-194. Cambridge: Cambridge University Press.

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英語音節劃分的基本原則

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音節自 1970 年代起已被視爲重要的音韻單位。雖然在學術上音節所獲得的關注以及它在音韻學中的重要性與日俱增，然而學界對於如何劃分音節卻一直沒有定論。本研究回顧相關的文獻，探討音節在口語與書寫的過程中所扮演的角色，進一步歸納出英語音節劃分的基本原則，希冀將其應用於英語教學，尤其是應用於教導母語的音節結構比英語簡單的學習者。

關鍵詞：音節、音節結構、書寫音節劃分、語音音節劃分