Syllable Structure Universals
and Second Language Acquisition

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ABSTRACT

The purpose of this paper is to review research in L2 acquisition that has examined the influence of syllable structure universals on the structuring of interlanguage phonology, research that essentially began in the early 1980's. Not all of the researchers conducting these studies claimed to be examining the influence of syllable structure universals; instead, a number of them expressly stated that they were examining the influence of typological universals, most of which were documented in Greenberg's (1965) seminal research. However, many of Greenberg's implicational statements are completely in accordance with current theoretical descriptions of the syllable; consequently, the L2 research based on the those implicational statements offer evidence for the influence of syllable structure universals on the structuring of interlanguage phonology.

The paper begins with a brief description of syllable structure universals, brief because only those syllable structure universals that have inspired corresponding research in L2 acquisition are presented. The presentation also assumes that the syllable has three constituents: the onset, the nucleus, and the coda. Such a division is in accordance with much of the research on the syllable, and dividing the syllable into these three constituents facilitates both the description of the universals and the review the L2 research.

KEYWORDS: syllable, onset, language universals.

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I. SYLLABLE STRUCTURE UNIVERSALS

1.1. The CV Syllable as an Absolute Universal

All descriptive and theoretical studies of the syllable recognize that the CV syllable is an absolute universal in the languages of the world (Battistella, 1990; Blevins, 1995; Cairns & Feinstein, 1982; Clements, 1990; Greenberg, 1965; Kaye & Lowenstamm, 1981; Hulst & Ritter, 1999; Vennemann, 1988. Vememann (1988) explicitly expresses this universal in sections of his Head Law and Coda Law. Part A of his Head Law (where head is synonymous with onset) states that "a syllable head is the more preferred: (a) the closer the number of speech sounds is to one" (p. 13). In turn, Part A of the Coda Law states that "a syllable coda is the more preferred: (a) the smaller the number of speech sounds in the coda" (p. 21). Thus, a single C is the optimal onset and a zero C is the optimal coda, meaning that the CV syllable is the core syllable in all languages.

Research in historical linguistics has demonstrated that syllable structure changes abide by syllable preference laws, and that "if a change worsens syllable structure, it is not a syllable structure change,...but a change on some other parameter which merely happens also to affect syllable structure" (Vennemann, 1988, p. 2). This means that diachronic examples should exist of CV syllables evolving from less preferred forms, such as V, CCV, and CVC syllable types.

As expected, examples of all these changes have occurred. Vennemann notes a number of historical cases in which headless syllables (V syllables) acquired a single consonant as an onset, thus producing a CV syllable. The following examples are from Italian (Vennemann 1988, p.14):

(1)			
Ge.nu.a	→	*Ge.no.va*	
Man.tu.a	→	*Man.to.va*	
Pa.du.a	→	*Pa.do.va*	
vi.du.a	→	*ve.do.va*	'widow'
ru.i.na	→	*ro.vi.na*	'ruin'

As demonstrated in the exarnples above, contiguous vowels begiming with a high back vowel developed a glide (step not shown) that eventually strengthened into the consonant /v/, which then acted as a one-member onset.

In addition to creating CV syllables from V syllables, languages also reduce CCV syllables to CV syllables as Vennemann (1988) has demonstrated from German language data (p. 15). Early Old High German (OHG) had some complex onsets consisting of /h/ followed by a consonantal sonorant. In late OHG the initial /h/ had disappeared resulting in one-member onsets:

(2)	**Early OHG**		**Late OHG**	
	hnigan	→	*nigan*	'to bow'
	hlut	→	*lut*	'loud'
	hruofan	→	*ruofan*	'to call'
	hwiz	→	*wiz*	'white'

Further examples of CCV syllables being reduced to CV syllables come from Pali (Vennemann, 1988, p.15):

(3)	ambm	→	amba	'mango'
	srotas	→	sota	'stream'
	svapna	→	soppa	'sleep'
	syandana	→	sandana	'wagon'

These examples from Pali demonstrate that the two-member onset /br/ was reduced to the one-member onset /b/ and that /sr/, /sv/, and /sy/ were each reduced to the one-member onset /s/.

Finally, CVC syllables have been reduced to CV syllables by the loss of the one-member coda as the following examples from Italian demonstrate (Vennemann 1988, p.14):

(4)	*patrem*	→	*padre* 'father'
	cantat	→	*canta* '(he) sings'
	fac	→	*fa* 'make!'
	dic	→	*di* 'say'

1.2. The Length of Margins

The markedness of margins (both onsets and codas) increases with length, a fact captured by the observation that the presence of onsets or codas of length n in all languages implies the presence of at least one subsequence $n - 1$ in the corresponding positions (Greenberg, 1965; Kaye & Lowenstamm, 1981). This generalization holds true with the exception as noted by Greenberg that the presence of CV does not necessarily imply the presence of V (a syllable with a zero onset).

Evidence for a preference for shorter onsets and codas exists from both historical linguistics and from phonological processes from many languages, which reduce complex codas and onsets by vowel epenthesis or deletion; in contrast, very few examples exist in the world's languages of processes that produce complex onsets or codas (Blevins, 1995).

Historically, examples exist of languages losing at least some of their complex onsets as demonstrated in (2) and (3) for Pali and Old High German; other languages that have reduced

the number of their complex onsets include English and Greek (Hock, 1986). A large nurnber of languages have also lost sorne of their complex codas, such as Sanskrit and Greek (Hock, 1986).

I.3. Sonority Sequencing

All cross-linguistic descriptions of the syllable note that the segrnents cornposing syllables are pattemed in a certain rnanner based upon sonority. The preferred syllable type in all languages is one in which the nucleus is the most sonorant constituent and consequently, cornprised of a vowel; in tum, the segments cornprising the onsets and codas rise continuously in sonority frorn the rnost peripheral rnember; this pattem is known as the Sonority Sequencing Principle (Clements, 1990), and a model of it occurs in (5).

One-member onsets and codas by definition rnust adhere to the Sonority Sequencing Principle because they must be comprised of segments that are less sonorant than the nucleus. However, one-member onsets and codas differ drarnatically frorn each other in which segrnents are preferred. If an onset consists of one segrnent, a strong universal tendency exists for the segment to be weak in sonority, thus obstrnents are preferred over sonorants in that position. The reverses is tme for codas: One-member codas are preferred that are high in sonority.

(5)   <u>Nucleus</u>

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vowels

glides   glides

Onset   liquids   liquids   ***Coda***

nasals   nasals

fricatives   fricatives

stops   stops

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Universally preferred complex onsets are constmcted by selecting a segment lower on the sonority scale and following it with one higher on the scale; for exarnple complex onsets consisting of a stop followed by a liquid or a fricative followed by a glide adhere to the Sonority Sequencing Principle. In tum, complex codas are formed by selecting a segment higher on the scale and following it with one lower on the scale, so a nasal may be followed by a stop or a liquid may be followed by a fricative. Syllables adhering to the Sonority Sequencing Principle occur in all languages, and many languages have only syllables that adhere to it.

Though the Sonority Sequencing Principle expresses a very strong universal tendency, complex margins may violate it in two manners. First, two segments in a rnargin rnay have the same sonority; these are known as sonority plateaus (Clements, 1990) and are found in a few languages including English, as in the words *sphere* and *fact.* Second, the more peripheral segment in the onset or coda may have higher sonority than a segment closer to the nucleus; such

aberrant sonority profiles are known as reversals and occur in sorne languages including English as exernplified by *spin, sky, ax,* and *hops.* Sonority reversals are more serious departures frorn the Sonority Sequencing Principle than are sonority plateaus and are consequently less frequent and more rnarked.

One last point needs to be rnade about the Sonority Sequencing Principle and cornplex rnargins. Two cornplex onsets or codas can abide by sonority sequencing, yet one rnay still be preferred over the other cross-linguistically. This observation has been made in a nurnber of studies perhaps the rnost well-known being that of Greenberg (1965), who docurnented implicational relationships between pairs of consonant clusters. One such irnplication is that if a language has a two-rnernber onset consisting of an obstruent followed by a nasal, then is will also have one consisting of an obstruent followed by a liquid, rneaning that the former is more rnarked than the latter. An irnplicational relationship for codas is that if a language has a two-rnernber coda consisting of two nasals, then it will also have one consisting of a nasal followed by an obstruent'. These two irnplicational staternent seern to be part of a larger generalization: All else being held constant, cornplex rnargins are preferred that have a sharper rise in sonority frorn the rnost peripheral member[2]. Vennemann (1988) cites a nurnber of historical cases for this preference; in Greek, for exarnple, nasal + liquid onsets evolved into plosive + liquid onsets.

II. L2 RESEARCH
11.1. Preference for the CV Syllable

As discussed above, the CV syllable is an absolute substantive universal; all languages have CV syllables, and sorne have only CV syllables. Any syllable types that are more cornplex than the CV syllable are therefore rnarked, the degree of rnarkedness directly dependent on the degree of complexity. Given that CV syllables are unrnarked, sorne researchers in L2 acquisition hypothesized that the CV syllable would be produced in interlanguage independent of native language transfer. The evidence for this hypothesis has been sorne positive, but weak for a nurnber of reasons that will be presented below.

In the first study, Tarone (1980) transcribed the English narratives of two speakers each of Korean, Cantonese, and Portuguese and found that the participants rnodified 137 syllables (about 20% of the syllables that they produced) either through epenthesis, deletion, or the insertion of a glottal stop. Although rnost of the rnodifications could be attributed to native language transfer, 30 (about 22% of the rnodified syllables) could not and were therefore interpreted as evidence for a preference for the CV syllable.

Following the sarne procedures used by Tarone, Hodne (1985) exarnined the English syllable structure of two native speakers of Polish. Polish was chosen because it has syllable structures at least as cornplex as those found in English; in fact, Polish and English share at least 26 cornplex onsets and 26 cornplex codas. Hodne collected 666 syllables in an interview task and

a narrative. The corpus of data contained 66 syllable structure errors; of those 21 could not be attributed to transfer, and of those a mere 11 (about 16%) resulted in CV syllables.

Sato (1984) examined the spontaneous and informal English conversations of two Vietnamese youths. Data were gathered at three different points over a 10-month period. Sato selected Vietnamese because over 81% of the phonemic syllables in the language are closed. Given that Tarone (1980) had found that transfer was more prevalent in accounting for the syllable structure of the interlanguage than was any possible preference for the simple open syllable, speakers of Vietnamese offered an interesting case because a transfer hypothesis would predict that the participants would favor closed rather than simple open syllables in the interlanguage. Sato examined the production of two-member codas by the participants and found that of the 489 two-member codas produced over the 10 months, 363 were reduced (one member of the coda was deleted) and 61 were completely deleted. In other words, approximately 12% of the target syllables with two-member codas were reduced to CV syllables.

Benson (1988) taped two adult native speakers of Vietnamese in informal conversation with the investigator. Benson investigated both monosyllabic words consisting of an open syllable and a closed syllable ending in [p, t, k, m, n] or [ŋ] as Vietnamese has closed syllables ending in those segments. Three types of errors were examined: the insertion of a consonantal segment after a word-final V, the occurrence of an epenthetic vowel after a word-final C, and the deletion of a word-final C. Of the 537 target closed syllables, 92 were modified towards CV syllables through deletion, but only 11 of those resulting CV syllables could not be attributed to transfer.

Riney (1990) examined the syllable production of 40 native speakers of Vietnamese who were distributed equally among four age groups: 10-12, 15-18, 20-25, and 35-55. Riney restricted his examination to stressed monosyllabic words ending in the word-final one-member codas /t/, /k/, and /v/; environment was controlled so that only items followed by a vowel or a pause were examined. Riney examined two types of errors: epenthesis after a one-member coda or deletion of the coda, both modifications resulting in a CV syllable. The four groups differed on the frequency with which they modified the target onsets. The youngest group simplified the least frequently (15.8%) and used the strategy of deletion nearly twice as much as epenthesis. The next three groups each modified approximately one third of the target items (34.8, 30, and 38.7%, respectively), but they differed on the strategies that they used; with age epenthesis increases and deletion decreases[3]. This study indicates that even speakers of languages having word-final CVC syllables will variably modify some of them to CV syllables in the L2[4].

Two generalizations can be made from these studies, the first being that transfer is the primary process involved in modifying the syllable structure of the interlanguage; clearly, most modifications of syllable structure found in the studies just described could be attributed to transfer rather than to any preference for the CV syllable. Researchers have commented on how susceptible interlanguage phonology is to transfer from the L1. For example, Ioup (1984), in a comparison of phonological and syntactic modifications in interlanguage, remarked that transfer

appears to be more influential in **structuring** interlanguage phonology than in structuring interlanguage syntax. In fact, she states "that transfer is the **major** influence on interlanguage phonology" (p. 13).

Two studies that clearly demonstrate the influence of transfer on the structuring of interlanguage phonology **have been** conducted by Broselow. In the first study, Broselow (1983) investigated syllabification errors in the English of native speakers of Arabic who spoke two distinct dialects: Iraqi and Egyptian. Both dialects **have** syllable structure conditions that disallow consonant clusters in word-initial position. Yet speakers of each dialect **modify** English words with initial consonant clusters in a different manner. Egyptian speakers will pronounce *flow* as [filo] whereas Iraqi speakers will pronounce it as [iflo]. Both pronunciations can be attributed to **rules** of epenthesis in the native language that bnng underlying syllable structures into conformity with surface structure restrictions on syllable structure. In a word such as *flow*, the first consonant is extrasyllabic (unassociated with a nucleus) and a vowel must be inserted to which the consonant is resyllabified according to convention before it reaches surface structure (Clements & Keyser, 1983). The Egyptian rule of anaptyxis inserts a vowel to the right of the extrasyllabic consonant to which it resyllabifies forming a CV syllable. In contrast, the Iraqi rule of prothesis inserts a vowel to the **left** of the extrasyllabic consonant to which it resyllabifies forming a VC syllable. If the preference for the CV syllable had **been powerful**, Iraqi speakers might **have been** expected to pronounce words such as *flow* as [filo] at least **some** of the time **because** such a strategy would **have** created a CV syllable independent of L1 transfer; however, such pronunciation was not evident for Iraqi speakers. In the second study, Broselow (1984) studied the Arabic of native English speakers and found that they resyllabified Arabic to conform to English syllable structure conditions.

More **evidence** for the strength of L1 transfer over a preference for the CV syllable **also** comes from studies on the English of native Spanish speakers. In a number of independent studies, Carlisle (1988, 1991a, 1991b, 1997, 1998, in press) examined the production of /sC(C)-/ onsets in English. Spanish has a large number of words that begin with the sequence /esC/ such as escuela, estampa, and espia. For each word, the /e/ is predictable and consequently inserted by phonological rule. **Because** the epenthesis of /e/ takes place in the derivation of the words, the underlying representations begin with the sequence /sk/, /st/, and /sp/, which are prohibited onsets according to the syllable structure conditions of Spanish (Harris, 1983). Consequently, in the underlying representations /s/ is an extrasyllabic consonant, and Spanish speakers respond to this consonant by inserting a vowel before it. The resyllabification convention then applies forming a syllable of the extrasyllabic consonant and the prothetic vowel, the result being that the relevant derived words in Spanish begin with a VC syllable. This same rule of prothesis is transferred into Spanish/English interlanguage phonology. Spanish speakers will variably pronounce words such as snow, slow, and steep as as [esno], [eslo], and [estip], a pronunciation that results in the words beginning with a VC syllable. In none of the studies did the participants ever produce forms such as [seno], [selo], or [setip] as might be expected if the participants

really had a preference for the CV syllable independent of language transfer. Other studies have examined native Spanish speakers acquiring languages that have complex onsets begiming with /s/ or /ʃ/ such as Swedish (Abrahamsson, 1999; Hyltenstam & Lindberg, 1983), German (Tropf, 1987), and Italian (Schrnid, 1997); all these studies found that when the target onsets were modified at all, they were modified by prothesis nearly exclusively.

The second comment about the research is that though it has provided positive evidence for a preference for CV syllable independent of language transfer, the results have been rather weak. Some researchers apparently assumed that target syllables would have to be reduced to CV syllables in order to show the influence of language universals on L2 acquisition. Consequently, some of the research used target syllables that had complex codas, but complex codas are rarely reduced to CV syllables (as seen in the discussion of Sato's research), instead they are usually reduced by one consonant only, thus a CVCC syllable will be reduced to a CVC syllable. Though the CV syllable is the unmarked syllable type, syllable structures fall along a continuum of markedness. Thus, CVCC syllables are more marked than CVC syllables, which in tum are more marked than CV syllables. This begin true, it would not be necessary for an L2 learner to produce CV syllables to demonstrate that language universals were an influence in the interlanguage. If L2 leamers produce less marked structures, rather than the unmarked, independent of language transfer, then linguistic universals can reasonably be claimed to be an influence. For example, if L2 learners whose native language has only CV syllables produce a CVC syllable instead of a CVCC target syllable, they have not only produced a syllable not found in their native language, but one that is also less marked. This point is brought out clearly in the following section.

11.2. The Length of Margins

As mentioned previously all descriptive and theoretical studies of the syllable have found that the markedness of both onsets and codas increases with length (Caims & Feinstein, 1982; Greenberg, 1965; Kaye & Lowenstamm, 1981; Vememann, 1988), a fact captured by the observation that the presence of an onset or coda of length n implies the presence of n - *1* (Greenberg, 1965; Kaye & Lowenstamm, 1981). Researchers in L2 phonology have hypothesized that L2 leamers would modify more marked margins more frequently than less marked ones. Results from a good number of studies have uniformly supported this general hypothesis.

Weinberger (1987) examined word-final codas produced by four adult speakers of Mandarin and found that the frequency of modification increased linearly with the length of the coda; 5.5% of one-member codas were modified, 29.8% of two-member codas, and 42% of three-member codas. In other words, as markedness increased, so did the frequency of the syllable simplification strategies.

In a study on the modification of both onsets and codas, Anderson (1987) examined the

casual conversation of 29 speakers of colloquial Egyptian Arabic, and 10 speakers each of Amoy and Mandarin Chinese and found that all groups of participants made significantly more modifications (either by deletion or epenthesis) of margins as their length increased. Arabic speakers did not modify one-member onsets at all, but they did modify over 7% of two-member onsets. The Chinese speakers produced similar results, modifying 1% of the one-member onsets, but over 10% of the two-member onsets.[5] For each group, an increase in the length of the onset produced a statistically significant increase in the frequency of modification. Results for the codas were similar. The native Arab speakers modified only about 2% of one-member codas, 17.4% of two-member codas, and over 30% of three member codas. The Chinese participants modified about 20% of the one-member codas, 50% of the two-member codas, and about 74% of the three-member codas. As was true for onsets, increases in length of codas produced statistically significant increases in the frequency of modification.

In another study, Eckman (1991) examined the reduction of complex codas and onsets by 11 native speakers of three different language: Japanese, Cantonese, and Korean, none of which allow complex codas or onsets. Unlike Anderson and Weinberger, Eckman did not compare the frequency with which two-member and three-member onsets and codas occurred relative to each other Instead, he used a criterion measure of 80% correct production to determine the presence or absence of a particular structure. For example, if a participant produced onsets of the form /spr-/ correctly 80% of the time, the structure was regarded as present in the interlanguage phonology. And if either or both of the two subsequences (/sp/ and /pr/) reached the criterion level, then they were also present and the hypothesis that the less marked margins would reach the criterion level before the more marked ones was confirmed. The hypothesis could have been falsified if the three-member margins was present and both of the two-member subsequences were absent according to the 80% criterion. Eckman examined three three-member onsets and eight three-member codas across 11 participants and four tasks and found three falsifications; that is, in three cases, a three-member cluster was present at the criterion level, but both two-member subsequences were absent. However, these three falsifications were by two participants and did not occur in all tasks. Even with the falsifications, this study provides very strong evidence that less marked onsets and codas are acquired before more marked onsets and codas.

In a recent study Hancin-Bhatt (2000) examined the production of five classes of one-member codas —voiceless stops, voiced stops, fricatives, liquids, and nasals— and three two-member codas —liquid + stop, liquid + fricative, and liquid + nasal— by 11 native Thai speakers. She found the participants correctly produced 84.4% of the one-member onsets and only 63% of the two-member onsets. Because the investigator was working within the framework of optimality theory, she did not analyze the data statistically.

Carlisle (1997, 1998, in press) in a five year longitudinal study on the acquisition of /.sC(C)/ onsets by native Spanish speaking adults examined the question of whether more marked onsets are modified more frequently than less marked onsets. At all three times of data

gathering, the researcher examined the production of the two-member onsets, /sp/ and /sk/, and the three-member onsets, /spr/ and /skr/. The data gathering instrument, which consisted of 176 topically unrelated sentences, was constrained in two important manners. First, only onsets that violated the Sonority Sequencing Principle were examined because previous research had determined that onsets that violate it are modified significantly more frequently than those that do not (Carlisle, 1991b; Tropf, 1987). Second, the phonological environment before the onsets was controlled as previous research has determined that native Spanish speakers use prothesis significantly more frequently after consonants than after vowels before /.sC(C)/ onsets (Carlisle, 1991a, 1991b, 1992). Results from Time I revealed that the 11 participants simplified 38% of the two-member onsets and 48% of the three-member onsets, a statistically significant difference ($p < .01$).

      The research question for Time II and III was different than that used at Time I. For Time II and III, the general hypothesis was that the less marked onsets would be acquired before more marked onsets. Acquisition was determined through the use of a criterion level of 80% correct production, the same criterion that had been used in previous research (Andersen, 1978; Cancino, Rosansky, & Schumann, 1975; Eckman, 1991; Eckrnan & Iverson, 1993). That is, if L2 learners produced a certain structure correctly 80% of the time, then that structure was considered acquired. Since the two-member onsets, /sp-/ and /sk-/, are less marked than are the three-member onsets, /spr-/ and /skr-/, they should have reached the criterion level before the more marked onsets. The hypothesis would not have been supported if either of the more marked onsets reached the criterion level before the less marked onsets. Ten participants were still available at Time II and thus 20 tests of the general hypothesis were possible. Two cases supported the hypothesis in that the less marked onset reached the criterion level before the corresponding more marked onset. The other 18 tests were consistent with the hypothesis in that either both onsets reached the criterion level, or neither did. Most importantly, no tests failed to support the hypothesis. Only four participants remained at Time III, permitting 8 tests; all results were consistent with the hypothesis.

      In a longitudinal case study, Abrahamsson (1999) tracked the production of /.sC(C)/ onsets in Swedish by a native Spanish speaker. Abrahamsson's participant was a beginning learner of Swedish who was taped nine times over a ten month period. During that time he modified .77 of the three-member onsets that he produced and .59 of the two-member onsets, a statistically significant difference ($p < 01$).

      All of the studies reviewed in this section have produced uniform results: Longer onsets and codas are modified significantly more frequently than shorter onsets and codas. Consequently, L2 learners acquire shorter onsets and codas before the longer ones.

11.3. Sonority Sequencing
11.3.a. The Sonority of Codas

As discussed previously, a universal tendency exists for one-member codas to be comprised of sonorant consonants. Some research exists demonstrating that L2 learners will delete less sonorant one-member codas more frequently than they will more sonorant one-member codas.

Tropf (1987) examined the deletion of one-member codas and found that the lesser the sonority of the segment comprising the coda, the higher the fiequency of deletion Thus, plosives were more fiequently deleted than fricatives, fiicatives more frequently than nasals, and nasals more frequently than liquids. This finding supports the universal tendency that more sonorant codas are preferred over less sonorant codas.

II.3.b. Preferred Complex Margins

A number of studies have found complex margins that are more preferred universally are modifíed less frequently than those that are less preferred. As discussed in the section on sonority sequencing, onsets consisting of an obstruent + liquid are less marked than those consisting of an obstruent + nasal because the presence of an obstruent + nasal onset implies the presence of an obstruent + liquid onset. To test the possible influence of this implicational universal in L2 acquisition, Carlisle (1988) examined the frequency of epenthesis before the onsets /sl/, /sm/, and /sn/, the hypothesis being that epenthesis would occur less frequently before the obstruent + liquid onset than the obstruent + nasal onsets because the former is less marked than the latter.

For this study, 14 native Spanish speakers read a list of 435 topically unrelated and randomly ordered sentences, 145 sentences each for /sl/, /sm/, and /sn/. Environment was strictly controlled because, as discussed previously, studies had revealed that epenthesis occurred significantly more fiequently after consonants than after vowels before word-initial /sC/ onsets in Spanish/English interlanguage phonology (Carlisle, 1991a).

The mean proportions of epenthesis before the three onsets were .29 for /sl/, .38 for /sm/, and .33 for /sn/; an ANOVA produced a significant difference among the three means. Pairwise comparisons revealed that the mean frequency of epenthesis before /sl/ was significantly less than those before /sm/ and /sn/ as hypothesized. In addition, /sm-/ was also more frequently modified than was /sn-/, although the two onsets are not in any known markedness relationship. However, the segments in the latter onset are homorganic and may be easier to articulate, as indicated by Greenberg (1965) who found that for codas a sequence of a nasal and a homorganic obstruent is less marked than a nasal followed by a heterorganic obstruent; and although no similar universal relationship has been expressed for onsets, the same relationship may hold in a richer theory of markedness. Another possible explanation may be found in Clements's Sequential Markedness Principle (1990, 313) stated below:

(6)   For any two segments **A** and B and any given context X Y, if A is simpler than B, then XAY is simpler than XBY.

Given that anterior coronals are less marked than are labials, then the sequence /sn/ is less marked than /sm/ and should therefore be modified less frequently.

Results from a recent case study of a native Spanish speaker leaming Swedish seem to contradict the findings in Carlisle's reseearch just discussed. Abrahamsson (1999) found that his participant actually modified /sl-/ onsets more frequently than he did /sn-/ onsets though the result was not statistically significant. However, as Abrahamsson notes, the corpus of data contained only 44 cases of /sl-/ and 67 cases of /s/ followed by a nasal. In addition, although Abrahamsson took environment into account and found that prothesis occurred significantly more frequently after word-final consonants than after word-final vowels as had been found in previous research (Carlisle, 1991a, 1992, 1997), he did not perform a sub-analysis of the environments before just the two onsets in question. Consequently, if a greater percentage of word-final consonants appeared before /sl-/ and before /sN-/, where N equals nasal, then a greater frequency of epenthesis would be expected before /sl-/ than before /sN-/, a result attributable to environment rather than to the markedness relationship between the target onsets.

II.3.c. Sonority Plateaus and Reversals

Several studies have provided evidence that margins abiding by the Sonority Sequencing Principle are modified less frequently than those that do not, plateaus and reversals. The first study with onsets was conducted by Tropf (1987) who examined German onsets produced by 11 native Spanish speaking adults. The data came from about one hour of taped conversations with each of the participants. Though the results are difficult to interpret because Tropf did not take environment into account, perform statistical analyses, or separate the findings for two-member and three-member onsets, his results suggest that onsets abiding by the Sonority Sequencing Principle are modified less frequently than those that do not.

In a later study that attempted to avoid the problems evident in the Tropf study, Carlisle (1991b) examined the production of /sl-/ and /st-/ onsets by 11 native Spanish-speaking adults; the two onsets differ in that /sl-/ conforms to expected sonority sequencing, and /st-/ is a sonority reversal. Since the latter is more marked than the former, it should be modified more frequently. Each participant read a reading instrument consisting of 290 sentences, each sentence containing one occurrence of a word-initial /sl/ or /st/; environment was strictly controlled before the target onsets. The frequency of epenthesis was .36 before /st/ and .25 before /sl/, a significant difference at $p < .0004$. Thus, the frequency of modification of the onset that violated the Sonority Sequencing Principle was significantly greater than the frequency of modification of the onset that did not violate it.

Findings reported by Major (1996) seem to contradict those just discussed. Major found

that native speakers of Portuguese learning English modified /sl/ onsets more frequently than /st/, /sp/, and /sk/ onsets. However, he also presents an argument that the seemingly aberrant findings may be attributed to positive transfer. Another possible exception comes form the work of Abrahamsson (1999) previously discussed. Ambrahamsson found that the participant in his case study modified .75 of 44 /.sl-/ onsets and .59 of 291 /.s + STOP-/ onsets. Again, however, these may be attributable to the small number of /.sl-/ onsets in the study and a to a possible confounding effect of environment.

A few studies have provided evidence that codas abiding by the Sonority Sequencing Principle are preferred over sonority plateaus and reversals. Tropf (1987) examined three codas that ended in a fricative — lateral + fricative, nasal + fricative, and plosive + fricative. The first two abide by the Sonority Sequencing Principle, and the last is a sonority reversal. Though Tropf did not perform a statistical analysis, the summary data in his tables clearly indicate that the 11 Spanish-speaking participants modified the plosive + fricative coda much more frequently than the two codas that abide by the Sonority Sequencing Principle. In addition, the participants modified the nasal + fricative coda more frequently than the liquid + fricative coda, which is in accordance with the universal tendency for those complex codas to be preferred that have a sharper rise in sonority from the most peripheral member. Tropf also examined four two-member codas having a plosive as the most peripheral member. Three of the onsets abided by the Sonority Sequencing Principle, and one was a sonority plateau. Again, the codas that abided by the Sonority Sequencing Principle were modified much less frequently than the one that did not.

Eckman (1987) examined the production of two-member and three-member codas by six participants, two speakers each of Korean, Japanese, and Cantonese and found that both two-member and three-member codas were reduced as expected. Although Eckman did not provide the frequencies with which two-member codas were reduced in relation to three-member codas, his study provides a revealing insight about the preference for codas that abide by the Sonority Sequencing Constraint. Eckman found that when his participants reduced three-member codas they tended to delete a segment that would result in one of the subsequences that abide by the Sonority Sequencing Principle. For example, a word such as *clasped* has a coda of the form [spt], which could be reduced to [sp], [pt], or [st]. In actual production, however, the participants normally produced the first and third variant; the second variant, a sonority plateau, rarely occurred. Though exceptions to the above generalization did appear, they may have been influenced more by morphology than phonology. In the rare cases in which a three-member coda, such as [pts] in *opts*, was reduced to the more marked subsequence consisting of a stop-stop, rather than to the less marked subsequence, the deleted fricative was always an allomorph of an inflectional morpheme, one that marked plurality or the third person singular of the present tense. In fact, if a three-member cluster consisted of two stops and a fricative, the fricative was deleted only if it were an allomorph of an inflectional morpheme; the fricative in such codas as [kst] as in *waxed* was never deleted. A number of studies have demonstrated that inflectional morphemes are frequently dropped by non-native English speakers (Moore & Marzano, 1979;

Politzer & Ramirez, 1973). This behavior is apparently so strong that it will be done even if the result is a more marked structure on the phonological level.

In a second study, Eckman (1991) measured the acquisition of two stop-stop codas (/-pt/ and /-kt/) and four fricative-stop codas (-ft/, /-sp/, /-st/ and /-sk/) against a criterion measure of 80% correct production, hypothesizing that the less marked codas would reach the criterion level before the more marked coda. By using four different tasks to gather data from 11 native speakers of Japanese, Korean, and Cantonese, Eckman found only two falsifications out of 44 tests of the hypothesis. In other words, in two cases at least one of the more marked codas reached the criterion level before any of the less marked codas did. The other 95% of the tests either supported the hypothesis or were consistent with it, providing evidence that less marked structures are more easily acquired than are more marked structures.

CONCLUSION

This study reviewed research in L2 acquisition demonstrating that syllable universals have a strong influence on the frequency with which L2 learners modifj syllables and on the order that they will acquire certain syllable types. Though research methodologies and analyses have differed from study to study, the results support the following claims:

> i) Leamers will produce CV syllables independent of language transfer.

> ii) Leamers will modifj longer margins more frequently than shorter margins with the result that the shorter margins are acquired before the longer margins.

> iii) Leamers will delete one-member codas at a frequency inversely related to their sonority —the greater the sonority the lower the frequency of deletion.

> iv) Leamers will modifj complex margins adhering to the Sonority Sequencing Principle less frequently than those that do not.

> v) Among complex margins that abide by the Sonority Sequencing Principle, some are more preferred than others; leamers will modifj the less preferred margins more frequently than the more preferred margins.

The research reviewed in this article found very few exceptions to the expected outcomes, and those may be attributable to a small amount of data, transfer from the L1, or to the influences of morphological processes or markedness principles unrelated to syllable structure universals.

NOTES

[1] Nearly all implicational statements for complex margins are written forthose consistingoftwo-members; implicational statements for longer margins are really non-existent.

[2] Whereas nearly all theoretical discussions of the syllable support this claim for complex onsets, the claim is more disputable for complex codas. For example, Clements (1990, p. 304-305) states that nasal-obstruent codas are preferred over liquid-obstruent codas, which goes against the current claim, but he also states that glide-obstruent codas are preferred over liquid-obstruent codas, which supports the current claim.

[3] These studies generated a great deal of discussion on the preferred strategies L2 learners use to produce CV syllables, epenthesis or deletion. It became apparentthat factors such as L1 background and age were highly relevant. (For a review see Carlisle, 1994).

[4] Several other studies that did not specifically study the preference for the CV syllable type may, nevertheless, offer insights into the modification of word-final syllables. Eckman investigated the strategies that native Japanese speakers (1981b. 1984) and native Mandarin speakers (1981a) used to modify word-final voiced obstruents. He found that the participants either produced the word-final obstruent without modification or else used schwa paragoge. The use of schwa paragoge may be attributable to the preference for the CV syllable. However, Eckman (1981a) noted that schwa paragoge also preserves more ofthe underlying structure and may be preferable for communicative reasons, rather than for phonological ones.

[5] No comparison was made between two-member and three-member onsets because not enough data was available.

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