Second Language Syllable Structure: Phonological Government and Typological Universals

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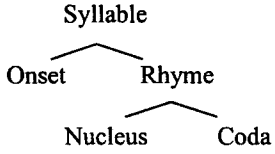
Second language learners commonly modify the syllable structure of their L2 words to match the syllable patterns found in their L1 words. Broselow and Finer (1991) propose a phonetically based minimal sonority distance parameter to account for their Korean subjects difficulties with English onset clusters. In contrast, Eckman and Iverson's (1993) claim that typological universals are sufficient to account for second language learner behavior. We propose a model of L2 syllabification based on a phonological minimal sonority distance parameter using derived sonority and phonological government. We argue that the acquisition of English onset clusters is linked to the acquisition of phonological contrasts and that similar to child language acquisition, a phonological contrast must first be acquired before it can be used as part of an onset cluster. This model both accounts for L2 errors and has the potential for telling us something about the mental representations of second language learners.

Introduction

In this paper, we investigate aspects of the acquisition of syllable structure by second language learners. We show that the behaviour of the second language learners can be explained using a model of segmental structure and phonological government in which segments with more structure cause greater difficulty than segments with less structure. We adopt the model of syllable structure shown in (1).

(1)



Languages vary according to whether syllabic nodes can branch. As well, it has long been noted that there are constraints on the sequences of segments that can occur in a syllable. One common pattern is that the sonority peak of a syllable is at its centre while sonority decreases towards the margins. A common phenomenon in second language learning involves modifying an L2 word so that it fits the L1 syllable structure. Broselow and Finer (1991) use the Sonority Sequencing Generalization (or Sonority Hierarchy) to account for the behaviour of Korean subjects acquiring English syllable structure. They draw on the notion of minimal sonority distances (MSD). Eckman and Iverson (1993), on the other hand, suggest that we do not need sonority distance to explain what second language learners are doing. They seek to improve upon Broselow and Finer's account of why Korean speakers learning English do what they do using typological universals rather than sonority distances.

In this paper, we will argue that a phonologically-defined notion of MSD will explain the performance of the learners in a way that Broselow and Finer's phonetically based MSD will not. We will also suggest that the typological view does not explain the behaviour of glides; nor does it have anything to say about the mental representations of second language learners.

The paper first discusses both Broselow and Finer's and Eckman and Iverson's approaches to L2 syllabification and then presents our explanation using derived sonority and phonological government. The conclusion discusses second language learners' access to universal grammar.

Previous Approaches to L2 Syllabification

Broselow and Finer

Broselow and Finer (1991) look at the acquisition of onset clusters in syllables. They adopt the sonority hierarchy shown in (2).

(2) Obstruents - Nasals - Liquids - Glides - Vowels
Least Sonorous ..... Most Sonorous

They assign a sonority value to each class which allows them to determine a sonority distance of allowable clusters. They adopt the sonority scale shown in (3).

(3)

Class	Value
Stops	1
Fricatives	2
Nasals	3
Liquids	4
Glides	5

So, a language with a MSD of five would only allow single consonant clusters. A language with a MSD of four would allow non-branching onsets consisting of stop-glide sequences. A language with a MSD of three would allow non-branching onsets consisting of either stop+glide or stop+liquid sequences. They conceive of this pattern as resulting from the setting of a multi-valued MSD parameter. The most restrictive parameter setting (MSD=5) generates the least marked set of elements: no onset consonant clusters. The less restrictive parameter settings generate the more marked onset clusters. On the basis of positive evidence, the parameter could be reset.

Broselow and Finer investigated 24 native speakers of Korean and 8 native speakers of Japanese. All subjects were called high intermediate in their English proficiency. Broselow and Finer had their subjects produce words with the initial clusters shown in (4).

(4) [pr], [br], [fr], [by], [py], and [fy]

Given the sonority scale in (3), Broselow and Finer assume the markedness relationships shown in (5).

(5) Less Marked ..... More Marked
Cy ..... Cr
pC ..... bC ..... fC

Therefore, [py] should be the least problematic cluster and [fr] the most difficult, since [py] clusters require a more restrictive setting of the MSD parameter than do [fr] clusters. (6) provides some of the relevant facts about Korean and English phonology (6)

(6)

Korean	English
Branching Onsets NO Minimal Sonority Distance 5 No [p]/[f] distinction; has labial stops No off glides Three stop series (fortis, lenis, aspirated) /r/ < [r] Elsewhere [l] V__ ([r] is in the onset and [l] is in the coda)	Branching Onsets YES Minimal Sonority Distance 3

So, Korean speakers learning English must determine that English onsets may branch and they must reset the MSD parameter to a less restrictive setting to allow stop+liquid onsets.

The chart in (7) presents the error rates for each individual consonant cluster (for the Korean speakers) as well as the total error rates (for the Korean speakers), and by and large, supports Broselow and Finer's predictions.

(7)

	py	pr	by	br	fy	fr
1. Total Errors	1/288	1/287	5/288	11/288	13/288	18/286
in %	2	2	10	22	27	37
2. Errors (--> CV)						
Epenthesis (CCV -->CVC)	0	0	1	8	0	0
Deletion (CCV --> CV)	1	1	4	3	5	6
Total	1	1	5	11	5	6
3. Errors in Manner						
Initial Replacement	0	0	0	0	8 (p)	11 (p) 1 (b)
Medial Replacement	0	0	0	0	0	0
Total	0	0	0	0	8	12

	Cy	Cr	pC	bC	fC
4. Total Errors (/864)	19	30	2	16	31
5. Errors (-->CV)	11	18	2	16	11
6. Errors in Manner	8	12	0	0	20

Broselow and Finer argue that clusters not sanctioned in the L1 as well as universal markedness effects account for the differential error patterns seen in (7). For example, Korean doesn't allow either [p] or [b] clusters, yet we see that [p] clusters cause less difficulties than [b] clusters. This difference can be explained using the MSD parameter and provides evidence for the inclusion of voicing in sonority hierarchies. If voiced stops are more sonorous than voiceless stops, then the sonority distance between [p] and [r] is greater than the sonority distance between [b] and [r]. Therefore [pr] clusters are less marked.

When we look at the different repair strategies for Cy versus Cr clusters, we notice an interesting pattern that is unexplained in Broselow and Finer's analysis. With one exception, when the second member of a cluster is a glide, epenthesis is not triggered. In other words, subjects may well break up a Cr cluster be inserting an epenthetic vowel, but not a Cy cluster. As shown in Broselow (1988), epenthesis can be a repair strategy triggered by unsyllabified consonants. Consider the initial syllabification of the word 'free' in (8).

(8)

Since, Korean does not allow branching onsets, the initial consonant in (8) is left unsyllabified. This may trigger an epenthetic vowel, resulting in the well-formed L1 syllable structure in (9).

(9)

However, if glides are part of a complex nucleus, and not a complex onset, as has been argued for Korean (Kim-Renaud,1978), then the glide would not trigger epenthesis as there is no unsyllabified consonant. This can be seen in the syllabification of the word 'few' shown in (10).

(10)

Since, as shown, in the data presented in (7), glides do not normally trigger epenthesis, we assume that in Korean, glides are analyzed as part of the nucleus rather than as part of the onset.

Finally, Broselow and Finer note that if L2 learners were simply transferring their L1 parameter settings to the L2, they would treat all clusters as if they were L1 clusters. However, we have seen that they treat clusters differently in a way which is consistent with predictions made by minimal sonority distances. In other words, they treat more marked clusters differently than less marked clusters. Broselow and Finer's view, then, is that second language learners have access to UG, but that the starting point of their acquisition is the transfer of their L1 settings.

Eckman and Iverson

Eckman and Iverson (1993) provide a re-analysis of Broselow and Finer's data. They argue that typological universals rather than minimal sonority distances are all that is needed to explain the performance of Broselow and Finer's subjects. Eckman and Iverson assume the markedness relationships in (11).

(11)

Marked	*relative to*	*Unmarked*
fricatives		stops
voiced stops		voiceless stops
voiced fricatives		voiceless fricatives

Eckman and Iverson interviewed four native Korean speakers, four native Japanese speakers, and three native Cantonese speakers. These subjects were intermediate or high intermediate in their English proficiency. All subjects were recorded in casual conversations and the transcripts analyzed for occurrences of onset clusters. Eckman and Iverson set the threshold of success to be eight percent correct on a minimum of five attempts. The tables in (12) provide the raw data for each Korean speaker. The number on the left of the solidus indicates the number of correct versions of the target cluster; the number on the right the number of attempts. The clusters in **bold** indicate the clusters that were not attempted five times, while the clusters in ***bolded italics*** indicate those clusters that fell below threshold accuracy.

(12)

Table 1: YK Korean

Markedness		
Least		**Most**
pr/pl	br/bl	**py**
86/93	10/10	**0**
pr/pl	fr/fl	
86/93	28/28	
tr	dr	**tw**
9/9	6/6	**0/5**
tr	θr	
9/9	13/13	
kr/kl	gr/gl	**kw/ky**
4/4	16/16	**1/2**

Table 2: DP Korean

Markedness		
Least		**Most**
pr/pl	br/bl	**py**
43/46	31/21	**2/2**
pr/pl	fr/fl	
43/46	8/8	
tr	dr	**tw**
34/34	6/6	**3/4**
tr	***θr***	
34/34	***8/15***	
kr/kl	gr/gl	kw/ky
4/4	15/15	7/7

Table 3: JKY Korean		
Markedness		
Least		**Most**
pr/pl 20/20	br/bl 10/10	py 1/4
pr/pl 20/20	fr/fl 12/12	
tr 12/12	dr 11/11	*tw* *6/10*
tr 12/12	θr 7/8	
kr/kl 9/9	gr/gl 0	kw/ky 5/5

Table 4: SW Korean		
Markedness		
Least		**Most**
pr/pl 22/24	br/bl 14/14	py 2/2
pr/pl 22/24	fr/fl 7/7	
tr 9/9	dr 2/3	tw 1/1
tr 9/9	θr 4/4	
kr/kl 9/9	gr/gl 9/9	kw/ky 3/3

While Eckman and Iverson were seeking to validate implicational universals, and thus only investigated the patterns of individual learners, we have pooled the data in an attempt to get a picture of how their subjects were behaving as a group. The data given in (13) is a composite chart of the four Korean speakers.

(13)

p+liquid	t+liquid	k+liguid
171/183	64/65	26/26
b+liquid	d+liquid	g+liquid
65/65	25/26	40/40
f+liquid	θ+liquid	
55/55	32/40	
p+y	t+w	kw/ky
5/8	10/20	1/2

Eckman and Iverson claim that all that is necessary to account for the subjects' behaviour are the typological universals shown in (14)

(14) 1. Voiced Stop + Sonorant > Voiceless Stop + Sonorant
2. Voiced Fricative + Sonorant > Voiceless Fricative +Sonorant
3. Voiceless Fricative + Sonorant > Voiceless Stop + Sonorant

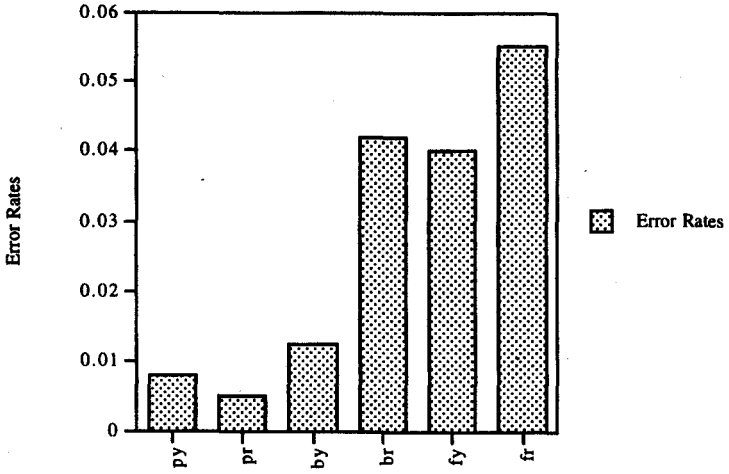
For the most part, they claim that the data support the theory. In 92% of the cases, the markedness predictions were upheld. While we would not necessarily disagree with this claim, we would argue that typological universals lack any explanatory value in terms of learner behaviour. They merely describe a pattern and have nothing to say about the mental representation of the learners (insofar as the learners are likely to be aware of the universals in question).

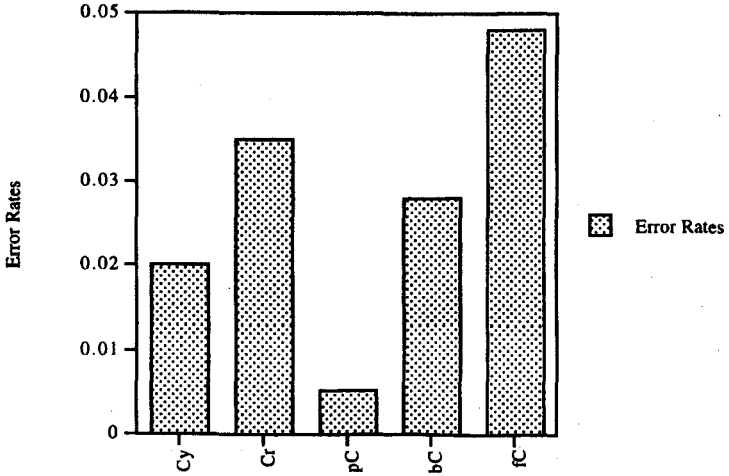
In addition, as the data in (12) and (13) illustrates, glide clusters were more problematic for these learners than the liquid clusters. Eckman and Iverson do not inform us as to the type of errors that the subjects made on these clusters. The typological approach, itself, has nothing to say about this differing behaviour between glide and liquid clusters.

Differences between the Studies

Before we discuss our phonological approach based on derived sonority and government, it is important to note two differences between the studies just discussed. First, the Broselow and Finer subjects were much worse on b-clusters than p-clusters, while the Eckman and Iverson subjects were marginally worse on the p-clusters. Second, the Broselow and Finer subjects made more errors on the C-liquid clusters than on the C-glide clusters, while the Eckman and Iverson subjects performed worse on C-glide clusters than on the C-liquid clusters. As it stands, we are currently unable to explain the differences between the populations (both are claimed to be intermediate to high intermediate in proficiency). Nor do there seem to be any non-phonological reasons (e.g. lexical frequency or morphological structure). It is worth noting, though, that the overall error rates are exceedingly low, and should force us to question whether we are witnessing ceiling effects in this analysis. The graphs shown in (15) for Japanese and Korean subjects should make this clear.

(15)


Error Rates
0.06
0.05
0.04
0.03
0.02
0.01
0
py
pr
by
br
fy
fr
Error Rates


Error Rates
0.05
0.04
0.03
0.02
0.01
0
Cy
Cr
pC
bC
fC
Error Rates

Finally, we also feel that the fact that both studies accepted any production of a liquid (either [l] or [r]) as acceptable may have missed an important source of information. Recall from (6), that unlike English, Korean lacks an /l/ / /r/ distinction. Our view is that learning to produce this distinction is not merely a matter of phonetic implementation (after all Korean has both sounds at the phonetic level), but rather is a matter of acquiring the appropriate mental representation based on the contrast in the sound system. It is highly likely that some of the subjects have acquired this distinction, while others have not. By mixing these populations, we might well have mixed performance for, as we shall see, we feel that there is a connection between acquiring the structure of English /l/ and producing consonant clusters containing [l].

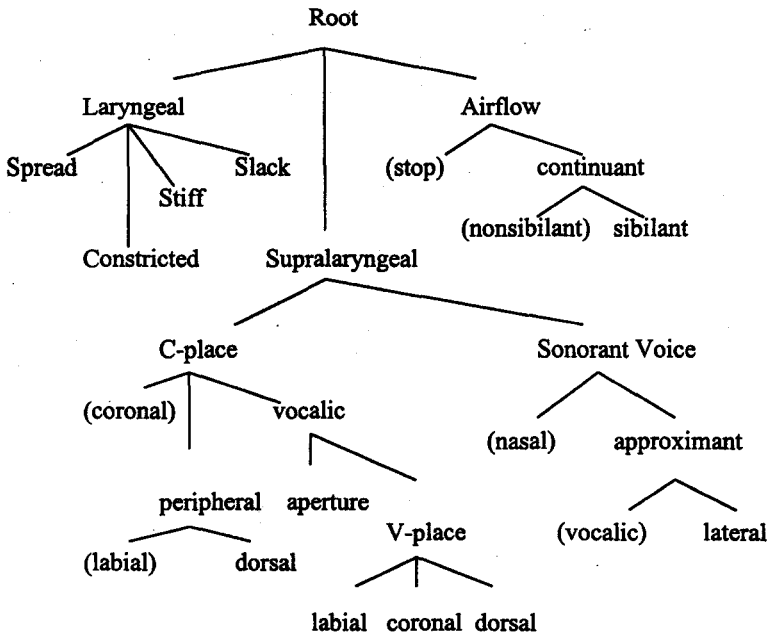
Syllabification based on derived sonority and phonological government

We propose that the behaviour of the Korean subjects can be accounted for within a model of hierarchical segment structure which treats sonority as a phonological construct derived from the complexity of segmental representations. This model has the potential of telling us something about the mental representations of the subjects, and links their acquisition of segments to the acquisition of the phonological inventory. Ultimately, there are still some things that we cannot account for due to the conflicting data of Broselow and Finer's and Eckman and Iverson's studies. We will first discuss the two important aspects of our model: derived sonority and phonological government, and then discuss how these can account for the acquisition of syllable structure by Korean speakers.

Derived Sonority

We adopt the model of segmental structure shown in (16).

(16)



The Spontaneous Voice (SV) node represents sonority. In general, the more SV structure a segment has, the more sonorous it is. This allows us to derive the sonority hierarchy in (17).

(17)

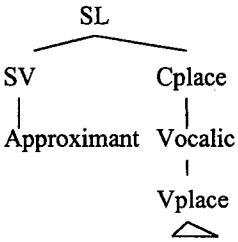
~~Ø~~	SV	SV	SV
		Approximant	Approximant
			Lateral
Obstruents	Nasals	/r/	/l/

Least Sonorous ..... Most Sonorous

As shown in (17), obstruents have no SV structure and therefore are the least sonorant, while /l/ is the most sonorant having the most SV structure. We note

that glides are absent from the hierarchy in (17). We assume that glides have the representation in (18), where SL refers to the Supralaryngeal Node.

(18) Glides:



According to (18), glides have just as much sonority as liquids, but differ from other consonantal sounds in that they have both Cplace and Vplace nodes. As we shall see, this representation allows us to derive the tautosyllabicity of stop+glide clusters in English.

It is important to remember that the structure of a segment is based upon the contrasts it is involved in phonologically. Rice (1995) shows how the representation of a lateral is dependent on the contrasts found in the segmental inventory. The structures in (19) show how a Korean liquid could have quite a different representation from an English liquid.

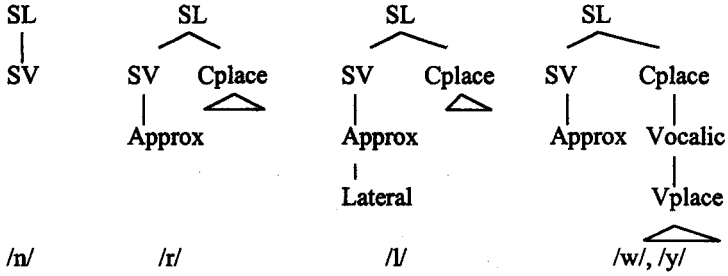
(19)

Korean: /n/-liquid/ contrast	English: /n/-/r/-/l/ contrast
SL	SL
|	|
SV	SV
|	|
Approximant	Approximant
	|
	Lateral

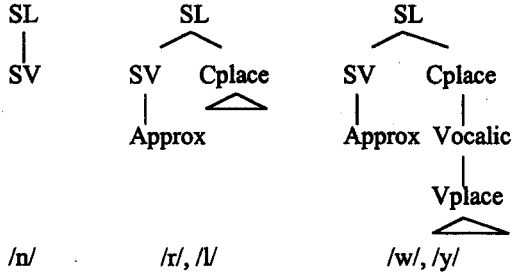
The acquisition of English [l], then, means the acquisition of the contrast between [l] and [r] which means the acquisition of the representation of [l], not just the phonetic ability to produce a lateral.

The trees in (20) show the segmental structure we are assuming for English, while the trees in (21) show the segmental structure we are assuming for Korean.

(20) English Segmental Structure



(21) Korean Segmental Structure



As (20) and (21) illustrate, the structure of the liquids differs between the two languages, while the structure of the glide remains constant. What differs in the two languages is whether the onglide is found in the onset (English) or the nucleus (Korean). And, as we shall see, this is the result of differences in syllabification between the two languages which we will discuss next.

Phonological Government

Following Rice and Avery (1992), we assume that phonotactic constraints result from universal principles of phonological government and syllabification

determined by deriving sonority via the segmental structure discussed in the previous section. We adopt the definition of phonological government in (22) and the syllable algorithm in (23).

(22) Government
A segment governs an adjacent segment if it has more feature structure than the adjacent segment within a governing domain. Sonorant Voice, Supralaryngeal, and Root are governing domains.

(23) Syllabification Algorithm

Process:	A segment (A) governs a segment (B)?
Possibilities:	Y (yes)/N (no)
Resulting Parse:	Y --> A and B are heterosyllabified
	N --> A and B are tautosyllabified

To account for the observed variation in allowable onset sequences cross-linguistically, we propose the minimal sonority distance parameter in (24).

(24) Minimal Sonority Parameter

Parameter:	SV government requires that the governor (B) must have at least X more nodes than the governee (A)
Settings:	X = 1, 2, or 3
Default:	X = 3

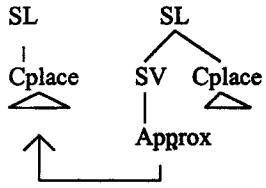
English and Korean have different settings of this minimal sonority distance parameter: English has a setting of X = 2 allowing stop+liquid onsets, while Korean has a setting of X=3 prohibiting onset clusters. Next, let's examine how (22), (23), and (24) along with derived sonority and the segmental representations in (20) and (21) account for the differences in English and Korean syllabification.

English and Korean Syllabification

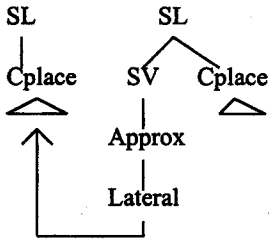
The structures in (25) show the allowable onset clusters in English.

(25) English Onset Clusters

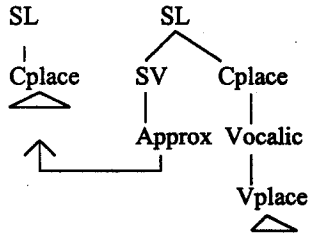
(a) p/b/f r



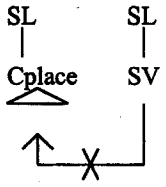
(b) p/b/f l



(c) p/b/f y



(d) p/b/f n

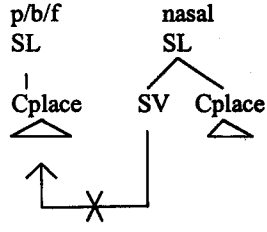


The first three clusters are well-formed tautosyllabically, since in each, the governor has at least two more SV nodes than the governee. The last cluster is not allowed in English, since the governor has only one more SV node than the governee.

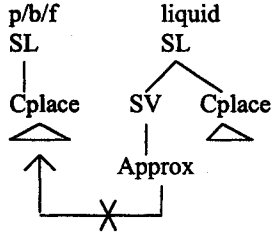
The trees in (26) show why Korean with a MSD of three does not permit any consonant clusters.

(26) Lack of Onset Clusters in Korean

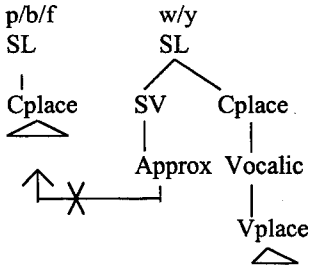
(a) p/b/f nasal



(b) p/b/f liquid



(c)



As shown in (26), an MSD of three prevents both nasals and, liquids, as well as glides from entering into the onset in Korean, since in all cases, the governor never has at least three more nodes than the governee. Finally, let's look at the acquisition of English syllable structure by Korean speakers.

Acquisition of English Syllable Structure

There are four important points we need to make concerning the acquisition of English syllable structure by Korean speakers. First, that Korean speakers are producing English onset clusters with few errors suggests that they have re-set the MSD parameter to the English setting. However, as noted, stop+glide clusters tend to be more problematic than stop+liquid clusters. This difficulty may arise because the Korean speakers must re-anaylze the glide from a nucleus to an onset position and this re-analysis might require negative evidence: the subjects would have to note that English does not allow the sequences in (27).

(27) *nwV, *lwV, *rwV (where V stands for vowel)

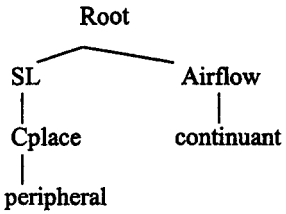
We assume that there is no positive evidence insofar as listening to the sequence of sounds would not be enough. That the cue to reanalyze the syllable structure requires negative evidence is consistent with the subjects' difficulty in this area. Young-Scholten (1994) has shown that areas of the L2 which require negative evidence may be difficult to learn. Another possible explanation, and one which avoids negative evidence might be found using segmental structure and government relations. If glides did not have any SV structure so that the only difference between glides and consonantal sounds is in place structure, then SV government could not account for their syllabification as no governing relation

would exist. However, since there is positive evidence that stop+glide clusters exist in English, this evidence might trigger an expansion in the governing domain opening up the possibility for other types of government such as Place to derive their tautosyllabification. It is also possible that there are restrictions on place government similar to SV government and that these restrictions may help to account for the lack of onset clusters shown in (27) as well as the lack of /pw/, /fw/ and /ty/ onset clusters in English as well as those clusters shown in (27). This remains an area for future research.

Second, let's go back to Broselow and Finer's and Eckman and Iverson's acceptance of any liquid-like production. In our model, the acquisition of [l] means the learner must add the lateral node. We would argue that the acquisition of this representation is an essential stop in acquiring English onset clusters. Vanderweide (1994) showed that children acquiring English as a first language did not start producing tautosyllabic onset clusters until they had acquired the appropriate representation for [l]. We would argue that the same is true for second language learners of English. A pilot investigation of three Korean speakers revealed that all of the subjects had acquired an [l] / [r] contrast and all had some onset clusters. This is consistent with the claim that the acquisition of /l/ is a necessary prerequisite for producing clusters.

Third, and relatedly, the fact that Broselow and Finer's subjects had more difficulty on the f-clusters in relation to the [p] and [b] clusters may also fall out from structural considerations. Recall that Korean lacks a [p] / [f] distinction. The acquisition of this distinction in English, requires that the learners elaborate the structure under the airflow node by adding the continuant node as shown in (28).

(28)



Again, structural markedness would explain the problem: continuant is the marked option under the Airflow node. Therefore, it must be acquired before it can be used within an onset cluster. This is consistent with Vanderweide's (1994) claim that children acquire the segments involving more structure in onsets later.

Finally, we must admit that derived sonority does not allow us to account for the difference in performance of Broselow and Finer's subjects on the p-clusters as opposed to the b-clusters. Most models of feature geometry simply assign a fan structure under the laryngeal node rather than one involving markedness relations. However, the differential performance of Broselow and Finer's subjects on [p] versus [b] might well have a partial explanation in L1 transfer. Korean has a three stop series: fortis, lenis, and aspirated. None of these are voiced as in English. If the subjects are transferring any of their L1 stops to English, the resulting stop would be voiceless. This would explain why the subjects are more accurate on [p] than on [b], but it would not necessarily explain why they were better on [p] clusters than [b] clusters. Our contention is that we may be witnessing processing limitations. Given the automatic production of [p], the subjects have more processing capacity to devote to the articulation of the cluster. In attempting to produce a [b] cluster, the subject has to focus on the production of a new stop and a new cluster. This type of explanation is appealing in that we note that Eckman and Iverson's subjects did not show this pattern. Such variation is often the result of processing factors.

Conclusion

Let us now consider the broader implications of this type of study. Consider now, someone whose first language does not allow branching onsets or codas. The universal principles of sonority will not be fully fleshed out in the L1. For example, they will not have any information on whether the sonority sequencing is respected within a constituent (onset or coda). As Steriade (1988:121) noted, if the glide goes into the nucleus, then the MSD is irrelevant:

> co-occurence constraints based on sonority distance are found exclusively within the pre or post nuclear section, and never between the nucleus and the pre-nuclear section.

It is an interesting question to ask whether the second language learners will be constrained by such universal principles. In this sense, the phonological study is analogous to studies of L2 syntax that ask whether subjects whose L1 does not have overt WH movement respect subjacency. We need to note as well, that some languages (like English and German) contain sequences that violate the Sonority Sequencing Generalization (i.e. /st/ and /ts/). The question remains: are L2

learners whose first languages do not allow clusters going to be aware of these violations? We would suggest that re-analyzing the Korean data within this framework provides interesting insights into the nature of the representation of interlanguage grammars. Broselow and Finer argued for access to UG based on phonetic facts. Our re-analysis shows that we can still claim that interlanguage grammars are constrained by such phonological principles as derived sonority. The Korean learners are showing evidence of sonority effects even though their L1 does not have branching onsets.

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